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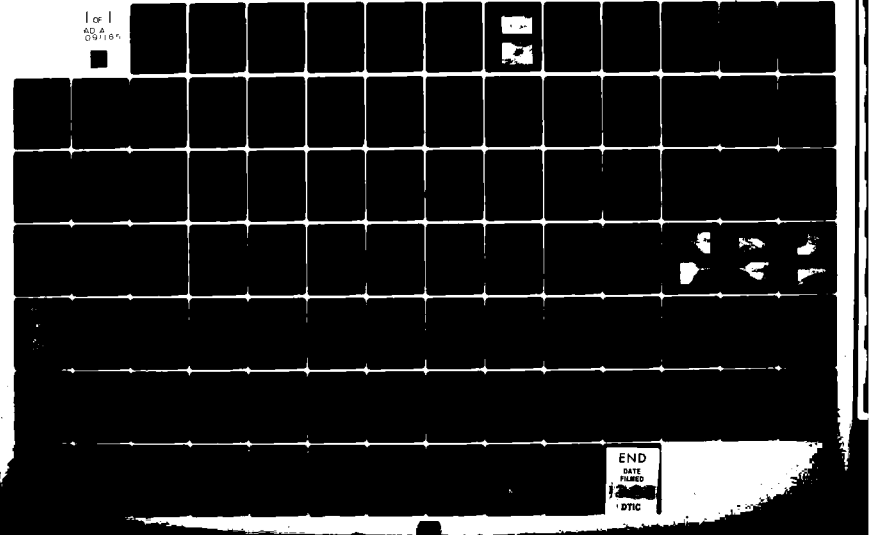


LEVEL II

OHIO RIVER BASIN

UNNAMED TRIBUTARY OF McGEE RUN, WESTMORELAND COUNTY

PENNSYLVANIA

(1)

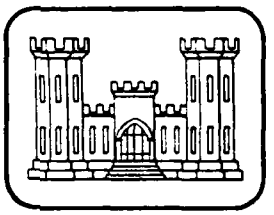
ETHEL SPRINGS DAM

NDI No. PA 01121

PennDER No. 65-13

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



prepared for

DEPARTMENT OF THE ARMY

Baltimore District, Corps of Engineers

Baltimore, Maryland 21203

DACW 31-80-C-0025

prepared by

MICHAEL BAKER, JR., INC.

Consulting Engineers

4301 Dutch Ridge Road

Beaver, Pennsylvania 15009

AUGUST 1980

OHIO RIVER BASIN

ETHEL SPRINGS DAM
WESTMORELAND COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI No. PA 01121
PennDER No. 65-13

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared for: DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

Prepared by: MICHAEL BAKER, JR., INC.
Consulting Engineers
4301 Dutch Ridge Road
Beaver, Pennsylvania 15009

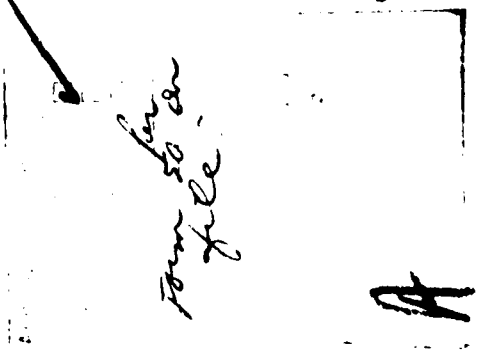
PREFACE

This report is prepared under guidance contained in the "Recommended Guidelines for Safety Inspection of Dams," for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.



PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Ethel Springs Dam, Westmoreland County, Pennsylvania
NDI No. PA 01121, PennDER No. 65-13
Unnamed Tributary of McGee Run
Inspected 23 June 1980

ASSESSMENT OF GENERAL CONDITIONS

Ethel Springs Dam is owned and operated by the Borough of Derry Municipal Water Authority. The dam is classified as a "High" hazard - "Intermediate" size dam. The dam was found to be in poor overall condition at the time of inspection.

Hydraulic/hydrologic evaluations, performed in accordance with procedures established by the Baltimore District, Corps of Engineers, for Phase I Inspection Reports, revealed that the spillway will pass approximately 40 percent of the Probable Maximum Flood (PMF) before overtopping will occur. A spillway design flood (SDF) equal to the PMF is required for Ethel Springs Dam. Additional analyses were performed to assess whether or not the dam would fail under 1/2 Probable Maximum Flood (1/2 PMF) conditions. Since the duration and depth of overtopping under the 1/2 PMF (6.0 hours and 0.28 feet, respectively) do not exceed the limiting criteria assumed for failure of the dam (8.0 hours and 1 foot), it has been estimated that failure of the dam under 1/2 PMF conditions is not likely. The spillway is therefore considered "inadequate" but not "seriously inadequate." The owner should immediately initiate an engineering study to further evaluate the spillway capacity and to develop recommendations for remedial measures to reduce the overtopping potential of the dam.

The possibility of movement of the upstream slope and the uncertainties of construction of the dike and downstream slope are causes for concern for the continued stability and safety of this dam. It is recommended that a detailed overall investigation of this dam be performed.

The inspection revealed certain items of remedial work which should be performed immediately by the owner. Items 1 through 6 below should be completed under the direction of a qualified professional engineer experienced in the design and construction of earth dams and appurtenant structures. These items include:

1) Immediate initiation of an engineering study to further evaluate the spillway capacity and develop recommendations for remedial measures to reduce

the overtopping potential of the dam. As a part of the analysis, detailed "as-built" information concerning the conduits should be obtained.

2) Initiate an engineering study to provide a quantitative assessment of the dam and dike stability and develop recommendations for remedial action as necessary.

3) As a part of the aforementioned studies, the "as built" condition of the dam should be determined and recorded on engineering drawings for future reference.

4) Repair the eroded and scoured areas on the upstream face of the embankment and install proper slope protection.

5) Provide upstream closure (i.e. gate valves) for the pipes passing through the embankment.

6) Properly repair the former breach in the dike.

7) Fill the animal burrows.

In addition, the following operational measures are recommended to be undertaken by the owner:

1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

It is further recommended that formal inspection, maintenance, operation and record-keeping procedures be developed and implemented.

ETHEL SPRINGS DAM

Submitted by:

MICHAEL BAKER, JR., INC.

John A. Dziubek, P.E.
Engineering Manager-Geotechnical

Date: 26 August 1980

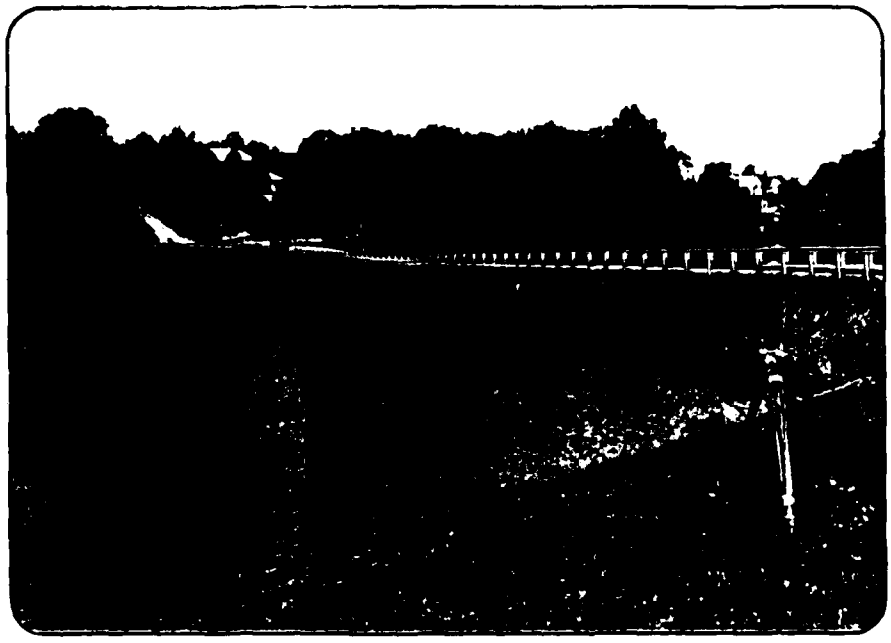
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 12 Sep 80

ETHEL SPRINGS DAM



Overall View of Upstream Face of Dam from Dike at Right Abutment

Overall View of Downstream Face of Dam from Left Abutment

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APPENDICES

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
ETHEL SPRINGS DAM
NDI No. PA 01121, PennDER No. 65-13

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority - The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose of Inspection - The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances - Ethel Springs Dam is a 43 foot high earthfill embankment with a crest length of 650 feet. The embankment has a crest width of 26.5 feet, a 1.25H:1V (Horizontal to Vertical) upstream slope (above normal pool), and a 1.8H:1V downstream slope. It is visually estimated that the upstream slope is flatter below the water surface. There are references in the Pennsylvania Department of Environmental Resources' (PennDER) file to a puddle cut-off being constructed in the foundation for the dam and it was estimated in the 1915 Water Supply Commission Report (one of PennDER's predecessors) that this puddle cut-off extended up into the embankment.

The spillway is located near the left abutment and consists of a drop-inlet with a 1 foot high by 4 foot wide orifice at Elevation 1185.0[1] feet Mean Sea Level (M.S.L.). The outlet for this structure is a 15 inch tile pipe which is reported "to curve around the left end of the dam." This pipe is joined by the 12 inch cast-iron blow-off pipe

[1] A spillway elevation of 1185.0 feet M.S.L. is used throughout this report. This elevation was obtained from the USGS 7.5 minute topographic quadrangle, Derry, Pennsylvania. An elevation of 1175.0 feet is shown on the 1900 design plate.

for this dam and both of these then exit through a 18 inch tile pipe into the natural streambed. A 10 inch cast-iron pipe serves as the water supply to the water treatment plant. (See Field Sketch - Appendix A.)

A diversion channel and dike was constructed along the entire right side of the reservoir. The flow in this channel is discharged around the dam by a drop-inlet structure with a 4 foot wide by 6 foot high opening. The outlet conduit for this structure is a 24 inch concrete pipe. The invert elevation of the opening is 1180.5 feet M.S.L. The minimum crest elevation on the dike is 1185.9 feet M.S.L.

An outlet and pump structure is located 75 feet upstream from the outlet structure for the diversion channel. This structure serves as a drain from, and a pump to, the authority's Chestnut Ridge Reservoir.

b. Location - Ethel Springs Dam is located in Derry Borough, Westmoreland County, Pennsylvania on an unnamed tributary to McGee Run. The coordinates of the dam are N 40° 20.3' and W 79° 18.5'. The dam and reservoir can be located on the USGS 7.5 minute topographic quadrangle, Derry, Pennsylvania.

c. Size Classification - The maximum height of the dam is 43 feet and the reservoir volume at the top of the dam is 493 acre-feet. Therefore, the dam is in the "Intermediate" size category.

d. Hazard Classification - The water treatment plant is located immediately downstream from the dam. Two homes are located 1300 feet downstream. An additional 6 houses and a sewage treatment facility are located 3300 feet downstream. Loss of life in these homes and facilities is considered likely in the event of a dam failure. In addition, a large area of the northwest corner of Derry may suffer damage in the event of a dam failure. Therefore, the dam is in the "High" hazard category.

e. Ownership - The dam and reservoir are owned by the Municipal Water Authority of the Borough of Derry, 620 North Chestnut Street, Derry, Pennsylvania 15627.

f. Purpose of the Dam - The dam and reservoir are used for water supply to the Borough of Derry.

g. Design and Construction History - Ethel Springs Dam was built in 1900 by H.F. Stark of Greensburg, Pennsylvania for the Derry Water Company. In 1915, the Pennsylvania State Board of Health directed the water company to construct a canal and dike along the left side of the reservoir in order to divert unsanitary development drainage away from the reservoir.

h. Normal Operational Procedures - The spillway is uncontrolled and the reservoir is typically at the spillway crest elevation (Elevation 1185.0 feet M.S.L.) except during periods of low rainfall and high water consumption. During the summer months, the blow-off is operated monthly. During March and April, the blow-off is typically left open. The dam has been inspected every two years, since 1972, by an engineering consultant firm.

1.3 PERTINENT DATA

a. Drainage Area (square miles) -	0.34
b. Discharge at Dam Site (c.f.s.) -	
Maximum Flood -	Unknown
Spillway Capacity at Minimum Top of Dam (El. 1188.9 ft. M.S.L.) -	59
c. Elevation (feet above M.S.L.) -	
Design Top of Dam -	Unknown
Average Top of Dam -	1191.0
Minimum Top of Dam -	1188.9
Maximum Design Pool -	Unknown
Normal Pool -	1185.0
Crest of Weir -	1185.0
Outlet Pipe - Invert at Entrance -	Unknown
Invert at Exit -	1145.7
Maximum Tailwater -	Unknown
d. Reservoir (feet) -	
Length of Maximum Pool (El. 1188.9 ft. M.S.L.) -	2600
Length of Normal Pool (El. 1185.0 ft. M.S.L.) -	2300

e. Storage (acre-feet) -

Minimum Top of Dam (El. 1188.9 ft. M.S.L.) -	493
Normal Pool (El. 1185.0 ft. M.S.L.) -	357

f. Reservoir Surface (acres) -

Minimum Top of Dam (El. 1188.9 ft. M.S.L.) -	35.7
Normal Pool (El. 1185.0 ft. M.S.L.) -	34

g. Dam -

Type -	Earthfill
Length (feet) -	650
Height (feet) -	43
Crest Width (feet) -	26.5
Side Slopes - Upstream - Design -	2H:1V
Field (above Pool Level) -	1.25H:1V
Downstream - Design -	1.5H:1V
Field -	1.8H:1V

Zoning - The information contained in the PennDER file indicates that a puddle core might have been constructed in the center of the dam. Plate 3 indicates that the upstream prism and central core of the dam was constructed with "select material - rolled." The downstream prism was "rough material dumped from wagons or carts."

Impervious Core - See the discussion on Zoning above.

Cut-off - The information contained in the PennDER file states that a puddle cut-off wall was constructed in the foundation beneath the dam. No specific information concerning depths and location was included.

Grout Curtain -	None
Drains -	None

h. Diversion and Regulating Tunnel - None

i. Principal Spillway -

Type - Drop-inlet spillway with a 1 foot high by 4 foot wide orifice and a 15 inch tile pipe outlet.

Length of Crest Perpendicular to Flow (feet) -	4
Crest Elevation (feet M.S.L.) -	1185.0

Gates - None
Upstream Channel - Reservoir
Downstream Channel - A 18 inch tile pipe exiting into natural streambed.

j. Drainage Canal Outlet -

Type - Drop-inlet with a 4 foot wide by 6 foot high opening and a 24 inch concrete outlet pipe.
Length of Crest Perpendicular to Flow (feet) - 4
Crest Elevation (feet M.S.L) - 1180.5
Gates - None
Upstream Channel - Canal along dike of reservoir
Downstream Channel - Natural stream channel

k. Regulating Outlets - A 12 inch cast-iron pipe serves as a blow-off for the reservoir. This pipe joins together with the 15 inch tile pipe from the principal spillway and flows to the natural streambed through a 18 inch tile pipe. A control valve for the blow-off is located a short distance downstream from the embankment. (See Field Sketch - Appendix A).

l. Water Supply Outlet - A 10 inch cast-iron pipe serves as the water supply to the water treatment plant. A control valve for this pipe is located downstream of the embankment. (See Field Sketch - Appendix A).

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The review of information for this dam included PennDER File No. 65-13. The following information is contained in the file for this dam.

1) Inspection reports, from 8 April 1915 to 13 July 1972, completed by representatives of PennDER (or its predecessors).

2) Information concerning cleaning and rehabilitation of the drainage intercepter canal and dike along the south side of the reservoir.

3) Miscellaneous correspondence including the Water Resources Inventory Form.

4) Two photographs of the dam, reservoir, and downstream area dated 8 April 1915; one photograph of the dam dated 15 June 1927; one photograph of the dam dated 26 March 1964; two photographs of the dam dated 24 June 1971; and two photographs of the dam dated 9 March 1972.

2.2 CONSTRUCTION

The dam was constructed by H.F. Stark of Greensburg, Pennsylvania in 1900. In 1915, a canal and dike drainage interceptor were constructed along the right side of the reservoir. The engineering for this canal was done by Knight and Hopkins of New York. There is no information available concerning who constructed the canal and dike. In 1922, fill from the excavation for the settling basin for the water treatment plant downstream from the dam was placed against the downstream toe of the dam. In 1974, plans for the cleaning and rehabilitating the canal and dike were prepared. The engineering was performed by the Gibson-Thomas Company, Inc. of Latrobe, Pennsylvania. This work was completed as a state project.

2.3 OPERATION

The reservoir is usually at the spillway crest level. There are no formal operational procedures for this dam.

2.4 EVALUATION

a. Availability - The information reviewed is readily available from PennDER's File No. 65-13. Additional information was obtained by interviewing the owner's personnel.

b. Adequacy - The information available is adequate for a Phase I Inspection of this dam.

c. Validity - At the present time, there is no reason to doubt the validity of the information reviewed.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General - The visual inspection was performed on 23 June 1980. No unusual weather was experienced prior to or during the inspection. The pool at the time of inspection was at Elevation 1185.0 ft. M.S.L. The dam and its appurtenant structures were found to be in poor overall condition at the time of inspection. Noteworthy deficiencies observed during the visual inspection are described briefly in the following paragraphs. The complete visual inspection check list, field sketch, top of dam profile, and typical cross-section are presented in Appendix A.

b. Embankment - The following is a list of observations made during the visual inspection of the embankment.

1) The upstream slope is fairly steep, especially above normal pool level where erosion and scouring has occurred.

2) The riprap on the upstream face has not adequately protected the embankment from erosion and wave action.

3) It appears that some localized movement of the upstream slope may have occurred at the location of a bowed section of guardrail (field Station 1+60) on the upstream edge of the crest. The owner reported that the guardrail had been hit by vehicles two times in this general area with one section requiring replacement. However, due to the possibility of movement of the slope and the very steep embankment above the water level (1.25H:1V at Station 2+00), it is recommended that a detailed investigation of the embankment slopes be performed.

4) The downstream slope is fairly steep and the outer surface of the upper portion of the embankment consists of very loose material.

5) Some reflective cracking has occurred near the edges of the roadway pavement on the crest of the dam. This cracking is typical of subgrade failure of the pavement after

widening of the road has occurred. Earlier photographs show that these cracks have been present for the past 16 years.

6) The central portion of the embankment (approximate field Station 2+25) is 4 feet lower than the embankment at the abutments. In 1972, a representative of PennDER compared this condition of the embankment with earlier photographs (taken in 1915) of the embankment and concluded that the embankment was constructed low in the center. It was recommended at that time that crest monuments, to monitor settlement, be installed. During the visual inspection, two such monuments were observed on the upstream face near the crest at field Stations 2+30 and 4+25.

7) Animal burrows are present at field Station 1+15 on the downstream face approximately 6 feet below the crest.

8) Animal burrows are present at field Station 1+70 on the downstream face at 4 and 6 feet below the crest.

9) Seepage was observed flowing from the reservoir, through the dike, to the diversion channel at several locations. The location with the greatest volume of flow was approximately 100 feet upstream from the outlet structure for the diversion channel. The flow at this spot was approximately 2.5 g.p.m. The seepage at this location, as well as at the other locations, was clear. No piping holes were observed.

10) At a point approximately 600 feet upstream of the outlet structure for the diversion channel, it appeared that the dike had experienced a small breach and was refilled with miscellaneous, uncompacted fill.

c. Appurtenant Structures - A 6 inch high course of bricks has been installed on the crest of the spillway orifice. This has reduced the size from 1.5 feet high to 1.0 feet high. The intake pipes have only downstream closure provided. No other problems were observed with the appurtenant structures during the visual inspection.

d. Reservoir Area - The reservoir slopes are mild and no instability was observed. According to the owner's representative, excavation of material (in the dry) has been taking place at the left, upstream side of the reservoir to remove an existing knoll and to eventually increase the reservoir capacity. According to the owner, sedimentation has not been a problem.

e. Downstream Channel - No obstructions were observed in the immediate area downstream from the dam. The water filtration plant is located immediately downstream from the dam. Approximately 1300 feet downstream are two homes. An additional 6 homes and a sewage treatment facility are located approximately 3300 feet downstream. A large area of the northwest corner of Derry may suffer damage in the event of a dam failure.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no formal, written procedures to be followed in the event of an impending failure of the dam. The reservoir is typically at normal pool level except during periods of high water consumption in the late summer months. Typically, the dam is inspected by an independent engineering firm every two years (since approximately 1972).

4.2 MAINTENANCE OF DAM

The Borough of Derry Municipal Water Authority is responsible for maintenance of the dam. At the present time, there are no formal procedures for maintaining the dam. It is recommended that formal maintenance procedures be developed and implemented.

4.3 MAINTENANCE OF OPERATING FACILITIES

The blow-off is typically operated once a month during the summer months. The water supply line valve is generally left open but has operated without problems in the recent past. The blow-off pipe is typically left open during March and April of every year. It is recommended that the procedures for operating the dam be formalized and records kept.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

At the present time, the civil defense and police departments would be notified in the event of impending failure of the dam.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

It is recommended that the maintenance, operation, and emergency procedures be formalized and records kept.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data - There is no detailed hydrologic or hydraulic design information available for Ethel Springs Dam. Only a limited amount of information is available concerning the configurations of the spillway and drainage canal outlet pipes. Consequently, it is not certain what the controlling pipe slopes in each outlet are. Therefore, it is recommended that, as part of the engineering analysis which will be required to decrease the overtopping potential of the dam, detailed plans of these pipes be prepared in order to determine their exact hydraulic parameters.

b. Experience Data - No records concerning the effects of significant floods on the dam are available. According to the owner's representative, the dam has never been overtopped. The dike separating the reservoir from the drainage canal was overtopped during Tropical Storm Agnes in 1972.

c. Visual Observations - No conditions which would indicate that the dam and appurtenances could not perform satisfactorily during a flood event were observed at the time of the inspection.

The dike which separates the drainage canal from the reservoir is in relatively poor condition. During an extreme storm event, this dike will be overtopped. The outlet for the canal is at Elevation 1180.5 feet M.S.L., 4.5 feet below the crest of the reservoir outlet. Therefore, overtopping or failure of the dike could provide the reservoir with an additional outlet if debris and sediment from the overtopping of the dike do not make it ineffective.

d. Overtopping Potential - Ethel Springs Dam is an "Intermediate" size - "High" hazard dam requiring evaluation for a spillway design flood (SDF) equal to the Probable Maximum Flood (PMF).

The hydraulic capacity of the dam, reservoir, and spillway was assessed by utilizing the U.S. Army Corps of Engineers Flood Hydrograph Package, HEC-1 DB. The hydrologic characteristics of the drainage basin, specifically, the Snyder's unit

hydrograph parameters, were obtained from a regionalized analysis conducted by the Baltimore District of the U.S. Army Corps of Engineers.

This analysis revealed that, during the PMF, the dam would be overtopped for a total duration of 13.5 hours at a maximum depth of 1.43 feet. The dam, reservoir, and spillways can only pass 40 percent of the PMF before overtopping begins.

e. Spillway Adequacy - As outlined in the above analysis, the dam would be overtopped by the SDF. The next criteria for determining spillway adequacy requires an estimate of whether the dam will fail during the 1/2 Probable Maximum Flood (1/2 PMF). The following conditions, as well as the overall state of the dam, were used as the limiting criteria which are likely to cause failure of the dam.

1) Depth of overtopping of 1.0 feet or greater.

2) Duration of overtopping in excess of 8.0 hours.

During the 1/2 PMF, the dam is overtopped by 0.28 feet for 6 hours; therefore, neither of these criteria are exceeded during the 1/2 PMF, which indicates that failure of the dam is not likely during the 1/2 PMF. Therefore the spillway is considered to be "inadequate" but not "seriously inadequate."

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - The erosion and scour on the upstream face of the embankment has made the upper portion (the portion above normal pool level) locally very steep. The presence of a bowed section of guardrail may be an indication of localized movement of the slope. It is recommended that the upstream face be properly repaired and adequate slope protection be installed. A detailed investigation of the embankment slope stability is required to be performed on the embankment slopes before this work is performed.

The presence of seepage and an uncompacted breach repair on the dike raises questions concerning the method of construction and long term stability of this dike. It is recommended that a detailed investigation of the dike be performed.

b. Design and Construction Data - Calculations of structural stability were not available for review. It was noted on an original design drawing that the downstream prism of the embankment was "dumped in layers from carts and wagons" but was not rolled. A 1923 inspection report notes that "material excavated from the settling basin built in 1922 was placed against the downstream toe of the dam". This explains the difference between the design of 1.5H:1V (Horizontal to Vertical) and the field determined slope of 1.8H:1V.

Given the uncertainties in the construction of the dam and dike and the presence of features which may indicate potential instability of the embankments, it is recommended that an overall detailed review of the dam, including quantitative assessments of the stability of the dam, be performed immediately by a qualified professional engineer experienced in the design and construction of earth dams.

c. Operating Records - Nothing in the readily available operational information indicates the need for concern relative to the structural stability of the dam.

d. Post-Construction Changes - The post-construction backfilling operation of the breach in the dike was not performed in a controlled manner. It is

recommended that this area be immediately repaired under the direction of a qualified professional engineer experienced in the design and construction of earth dams and appurtenant structures.

e. Seismic Stability - Ethel Springs Dam is located in Seismic Zone 1 on the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspections of Dams." This is a zone of minor seismic activity. Experience indicates that dams located in this zone will have adequate stability under seismic loading conditions if they have the recommended factors of safety of stability under static loading conditions. As indicated in paragraph 6.1.b., the dam may have marginal structural stability and further assessment of the static stability is recommended. If the evaluation and subsequent recommendations provide sufficient static stability factors of safety, further evaluations of the seismic stability are not warranted.

SECTION 7 - ASSESSMENTS, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety - Ethel Springs Dam was found to be in poor overall condition at the time of inspection.

Ethel Springs Dam is a "High" hazard - "Intermediate" size dam requiring an SDF equal to the PMF. As presented in Section 5, the spillway and reservoir are capable of passing only 40 percent of the PMF before overtopping begins. Based upon the analyses presented in Section 5 and Appendix D, the spillway is considered "inadequate." It is recommended that the owner immediately initiate an engineering study to further evaluate details of the "as built" condition of the pipes and to develop recommendations to reduce the overtopping potential of the dam.

The possibility of movement of the upstream slope and the uncertainties of construction of the dike and downstream slope all indicate the need for concern for the continued stability and safety of this dam. It is recommended that a detailed overall investigation of this dam be performed.

b. Adequacy of Information - The design and "as built" construction information is superficial at best. The observations and measurements made during the field inspection, combined with the information which could be assembled, are considered adequate for this Phase I Inspection Report. However, as part of the detailed evaluation of the spillway capacity, the controlling slopes of the conduits should be determined. In addition, information on the dam should be permanently recorded on "as built" plans for the dam.

c. Urgency - The owner should immediately initiate the additional investigations discussed in paragraph 7.1.d. and implement the recommendations in paragraph 7.2.

d. Necessity for Additional Data/Evaluation - The overall condition and uncertainties of this dam indicate that an overall detailed investigation is necessary. The owner should immediately initiate an engineering study including, but not necessarily limited to, the following items:

1) The hydraulic/hydrologic analyses performed in connection with this Phase I Inspection Report have indicated the need for additional spillway capacity. The spillway capacity should be further evaluated and recommendations developed for remedial measures to reduce the overtopping potential of the dam. As a part of this study, "as built" information concerning the outlet conduits should be determined.

2) The possibility of movement of the upstream slope, the steepness of the embankment slopes, and the uncertainties associated with the construction of the slopes and the dike has indicated the need for a quantitative assessment of the stability of the dam and dike. This assessment should include an investigation into the material properties of the embankment, a seepage analysis, a determination of the phreatic line, and a stability analysis.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection revealed certain items of remedial work which should be immediately performed by the owner. Items 1 through 6 below should be completed under the direction of a qualified professional engineer experienced in the design and construction of earth dams and appurtenant structures. These items include:

1) Immediate initiation of an engineering study to further evaluate the spillway capacity and develop recommendations for remedial measures to reduce the overtopping potential of the dam. As a part of the analysis, detailed "as built" information concerning the conduits should be obtained.

2) Initiate an engineering study to provide a quantitative assessment of the dam and dike stability and develop recommendations for remedial action as necessary.

3) As a part of the aforementioned studies, the "as built" condition of the dam should be determined and recorded on engineering drawings for future reference.

4) Repair the eroded and scoured areas on the upstream face of the embankment and install proper slope protection.

5) Provide upstream closure (i.e. gate valves) for the pipes passing through the embankment.

6) Properly repair the former breach in the dike.

7) Fill the animal burrows.

In addition, the following operational measures are recommended to be undertaken by the owner:

1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

It is further recommended that formal inspection, maintenance, operation and record-keeping procedures be developed and implemented.

APPENDIX A

VISUAL INSPECTION CHECK LIST, FIELD SKETCH, TOP OF DAM PROFILE, AND TYPICAL CROSS-SECTION

Check List
Visual Inspection
Phase 1

Name of Dam Ethel Springs Dam County Westmoreland State PA Coordinates Lat. N 40°20.3'

NDI # PA 01121
PennDER # 65-13

Long. W 79°18.5'

Date of Inspection 23 June 1980 Weather Sunny Temperature 80° F.

Pool Elevation at Time of Inspection 1185.0 ft.* M.S.L. Tailwater at Time of Inspection 1147.8 ft.* M.S.L.

*All elevations referenced to assumed spillway El. 1185.00 ft. M.S.L.

Inspection Personnel:

Michael Baker, Jr., Inc.:

James G. Ulinski
Wayne D. Lasch
Clifford E. Guindon

Field Review (8 August 1980):

John A. Dziubek
James G. Ulinski

Owner's Representatives:

Edward E. Shomo, Manager
Municipal Water Authority of
the Borough of Derry

James G. Ulinski Recorder

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: ETHEL SPRINGS DAM
NDI # PA 01121

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS		
DRAINS		
WATER PASSAGES		
FOUNDATION		

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: ETHEL SPRINGS DAM
NDI # PA 01121

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES		
STRUCTURAL CRACKING		
VERTICAL AND HORIZONTAL ALIGNMENT		
MONOLITH JOINTS		
CONSTRUCTION JOINTS		

EMBANKMENT

Name of Dam ETHEL SPRINGS DAM
NDI # PA 01121

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	Some reflective cracking has occurred near the edges of the roadway pavement from an earlier pavement widening. Earlier photographs show these cracks have been present for at least 16 yrs.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No cracking was observed at or beyond the toe. The upstream slope is submerged and could not be viewed. In the estimation of this writer, some localized movement has occurred at the location of the bowed guardrail (Station 1+60) on the upstream edge of crest. The owner indicated that these guardrails have been hit by cars several times and one section was previously replaced.	It is recommended that a detailed investigation be performed to ensure the continued stability of the upstream slope.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Erosion has occurred all along the upstream face of the dam at and above normal pool (the observable portion). The downstream slope is relatively steep and the embankment materials on the surface near the top are loose.	The eroded areas should be repaired.

EMBANKMENT

Name of Dam ETHEL SPRINGS DAM
NDI # PA 01121

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The entire center of the embankment is low. Apparently, from the earlier photos of the dam, it was determined that the central portion of the embankment was constructed lower. Two crest monuments have been installed to monitor any settlement.	
RIPRAP FAILURES	The riprap on the upstream face is not performing its intended function. The upstream face is eroding and the riprap is being washed out.	It is recommended that the erosion be repaired and additional slope protection be provided under the guidance of an engineer.
ANIMAL BURROWS	Animal burrows are present at field Station 1+15 on the downstream slope 6 ft. below crest level. Animal burrows are present at field Station 1+70 on the downstream slope at 4 and 6 ft. below the crest.	These animal burrows should be filled.

EMBANKMENT

Name of Dam ETHEL SPRINGS DAM

NDI # PA 01121

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No problems were observed.	
ANY NOTICEABLE SEEPAGE	Seepage through the dike between the reservoir and the diversion channel was occurring at numerous locations. This includes the location 100 ft. upstream from the outlet structure for the diversion channel where 2.5 g.p.m. was flowing through the dike.	It appears that this dike was not very well constructed; an investigation of the dike should be performed.
STAFF GAGE AND RECORDER	None	
DRAINS	None	
DIKE	In addition to the above mentioned seepage through the dike, it was observed that at a location approximately 600 ft. upstream from the outlet structure for the diversion channel, a breach in the dike had occurred. This breach was backfilled with miscellaneous, uncompacted fill.	This area should be removed and installed under the direction of a professional engineer experienced in the design and construction of earth dams and appurtenant structures.

OUTLET WORKS

Name of Dam: ETHEL SPRINGS DAM
NDI # PA 01121

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	A 12 in. C.I.P. is located through the dam for blow-off purposes. A 10 in. C.I.P. is used for water supply.	
INTAKE STRUCTURE	Both intakes were submerged and no detailed information was available. Neither pipe has an upstream closure.	Provide upstream closure for both pipes to protect the embankment in the event of pipe rupture.
OUTLET STRUCTURE	The outlet for the blow-off pipe is to the left of the treatment plant building and joins the outlet pipe from the spillway. The outlet pipe after the junction is a 18 in. diameter clay tile pipe.	
OUTLET CHANNEL	The outlet channel was free of debris and no problems were observed.	
EMERGENCY GATE	The gate valve for the 12 in. cast-iron blow-off pipe is typically operated once a month. The gate valve for the 10 in. cast-iron water supply pipe is typically left open all the time, but can function if necessary.	

UNGATED SPILLWAY

Name of Dam: ETHEL SPRINGS DAM

NDI # PA 01121

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The weir consists of a 1 ft. high by 4 ft. wide orifice in a cut sandstone structure (with concrete cap) near the left abutment. At some time in the past, a 6 in. layer of brick was placed on the weir reducing the size from 1.5 ft. to 1 ft. high. An iron grating is present on the opening.	
APPROACH CHANNEL	The reservoir serves as the approach channel.	
DISCHARGE CHANNEL	The discharge consists of a 15 in. tile pipe which curves around the left end of the dam and discharges from a 18 in. clay pipe by the treatment facility after joining the 12 in. C.I.P. blow-off pipe. The channel below this facility is free of debris and no problems were observed.	
BRIDGE AND PIERS	None	

GATED SPILLWAY - Not Applicable

Name of Dam: ETHEL SPRINGS DAM
NDI # PA 01121

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL		
APPROACH CHANNEL		
DISCHARGE CHANNEL		
BRIDGE AND PIERS		
GATES AND OPERATION EQUIPMENT		

INSTRUMENTATION

Name of Dam: ETHEL SPRINGS DAM

NDI # PA 01121

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	Two crest monuments are present on the upstream face at field Station 2+30 and 4+25.	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

RESERVOIR

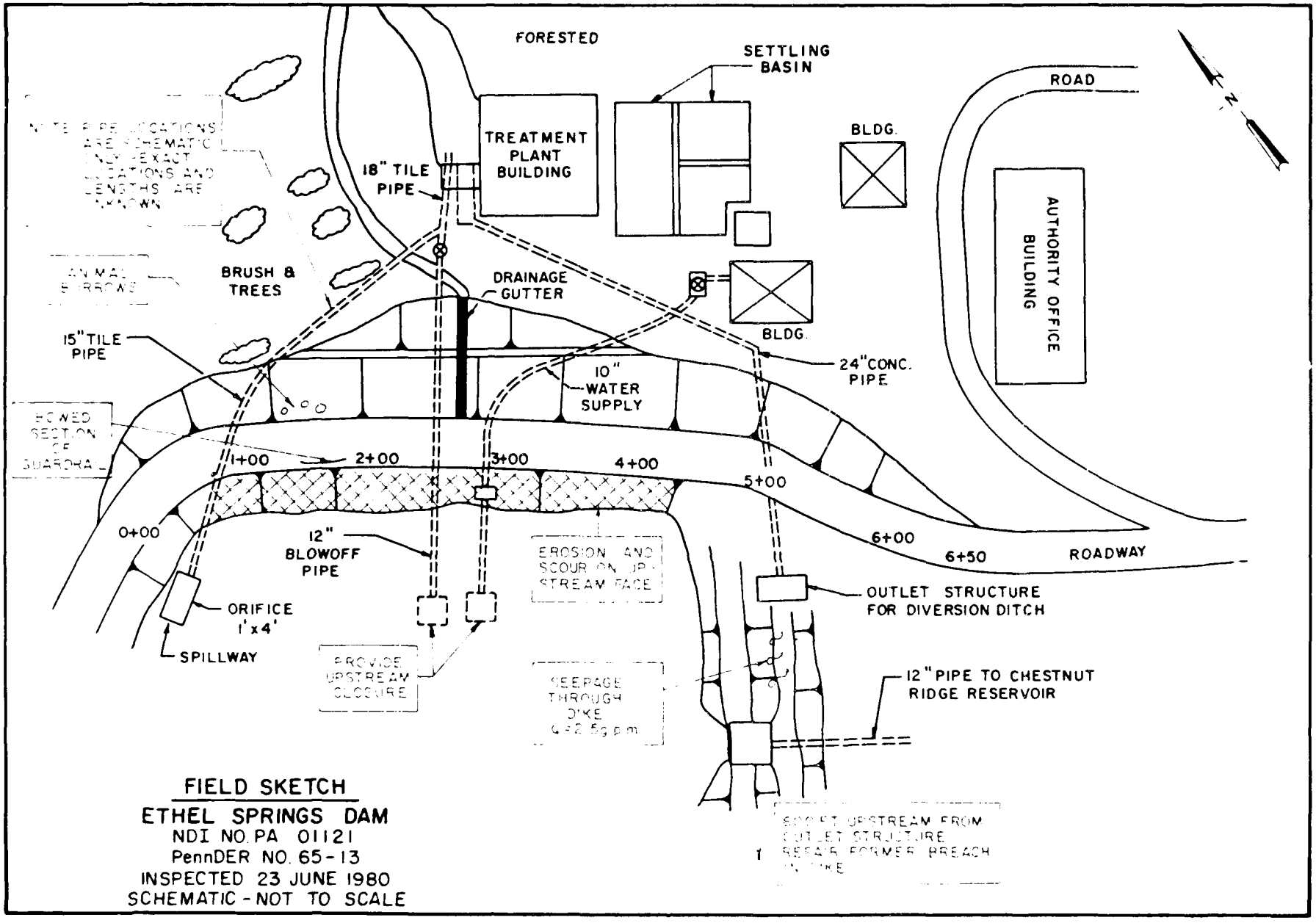
Name of Dam: ETHEL SPRINGS DAM
NDI # PA 01121

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The reservoir slopes are mild and no instability was observed. Excavation of material has taken place at the upstream left side of the reservoir to remove an existing knoll and eventually increase the storage capacity.	
SEDIMENTATION	The reservoir blow-off is typically operated once a month during the summer to partially remove some of the sediment accumulation. The owner did not indicate that sedimentation is a problem for this reservoir.	

DOWNSTREAM CHANNEL

Name of Dam: ETHEL SPRINGS DAM
NDI # PA 01121

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The sides of the channel are well vegetated but will not obstruct flow. One roadway bridge is located 1500 ft. downstream. Another bridge is located 3500 ft. downstream from the dam. This latter structure is 12 ft. wide by 8 ft. high.	
SLOPES	The side slopes of the channel are mild and no instability was observed. The channel slope is approximately 2.5% for the first 1000 ft. and then becomes approximately 0.5% to 1% for the next several mi.	
APPROXIMATE NO. OF HOMES AND POPULATION	The water filtration plant is located immediately downstream from the dam. Approximately 1300 ft. downstream are two homes. Located approximately 3300 ft. downstream are 6 homes and a sewage disposal facility. Additionally, a large area in the northwest corner of Derry may suffer damage in the event of a dam failure.	



FIELD SKETCH

ETHEL SPRINGS DAM
NDI NO. PA 01121
PennDER NO. 65-13
INSPECTED 23 JUNE 1980
SCHEMATIC - NOT TO SCALE

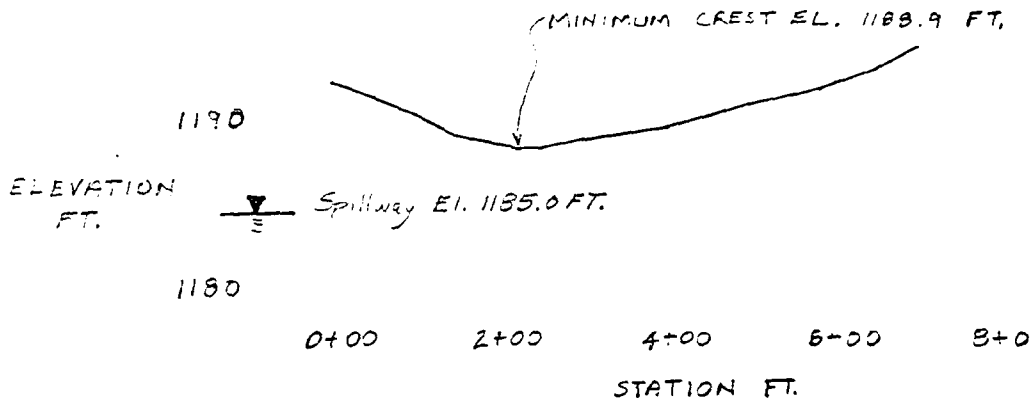
MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS
8 July 1980
Box 280
Beaver, Pa. 15009

EHTEL SPRINGS DAM

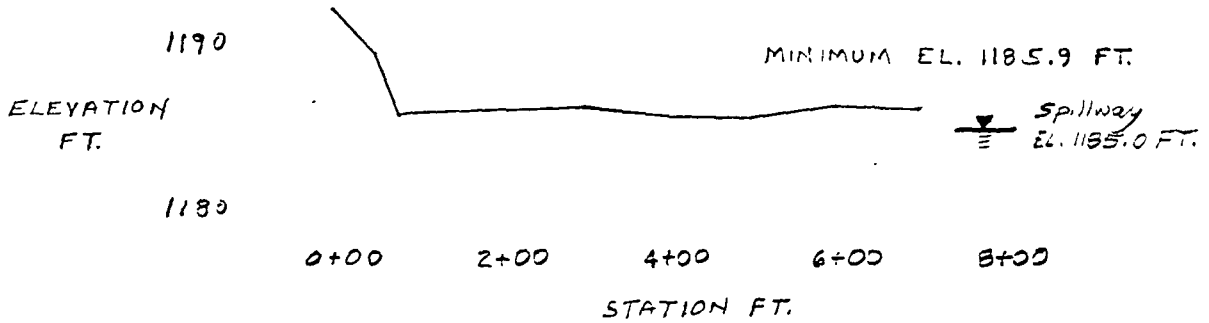
TOP OF DAM PROFILE
TOP OF DIKE PROFILE

DATE OF INSPECTION - 23 June 1980

TOP OF DAM PROFILE



TOP OF DIKE PROFILE



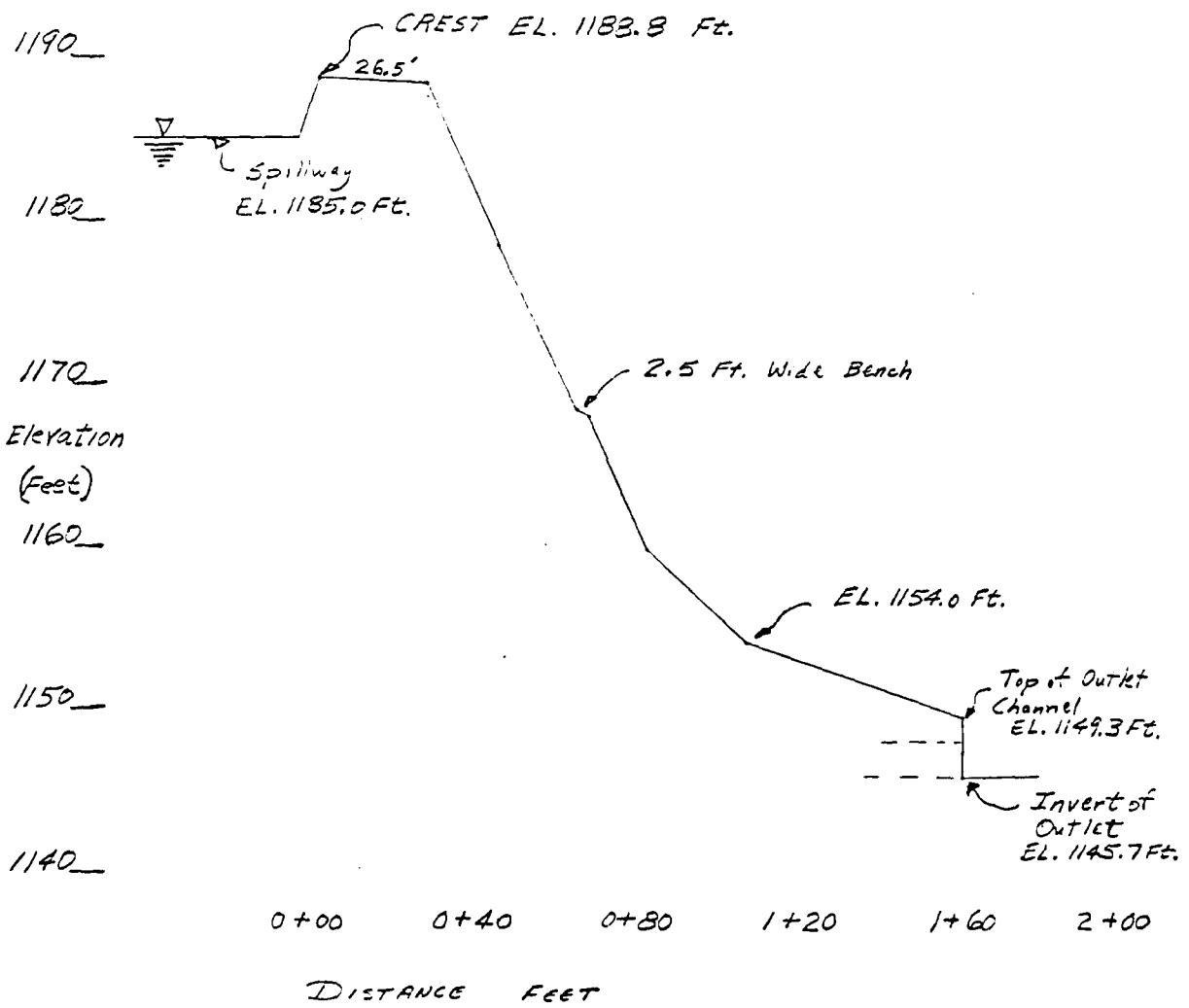
MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS
30 July 1980
Box 280
Beaver, Pa. 15009

ETHEL SPRINGS DAM

TYPICAL CROSS-SECTION

DATE OF INSPECTION - 23 June 1980

CROSS SECTION AT STATION 2+00



APPENDIX B

ENGINEERING DATA CHECK LIST

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

Name of Dam: ETHEL SPRINGS DAM
NDI # PA 01121

ITEM	REMARKS
PLAN OF DAM	See Field Sketch in Appendix A.
REGIONAL VICINITY MAP	A USGS 7.5 minute topographic quadrangle, Derry, PA was used to prepare the vicinity map which is enclosed in this report as the Location Plan (Plate 1).
CONSTRUCTION HISTORY	See Section 2 of this report.
TYPICAL SECTIONS OF DAM	See Plate 3 of this report.
HYDROLOGIC/HYDRAULIC DATA	No information available
OUTLETS - PLAN,	
DETAILS,	
CONSTRAINTS, and DISCHARGE RATINGS	No information available
RAINFALL/RESERVOIR RECORDS	None available

Name of Dam: ETHEL SPRINGS DAM
NDI # PA 01121

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	See Appendix F for the regional geology.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None available
POST-CONSTRUCTION SURVEYS OF DAM	According to the owner's representative, the embankment is inspected every two yrs. at which time the elevations of the crest monuments are determined.
BORROW SOURCES	No information available

Name of Dam: ETHEL SPRINGS DAM

NDI # PA 01121

ITEM	REMARKS
MONITORING SYSTEMS	Two crest monuments have been installed on the upstream face at field Station 2+30 and 4+25.
MODIFICATIONS	See Section 2 of this report for the modifications to the dam.
HIGH POOL RECORDS	None available
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	The only known post-construction engineering reports are inspections by representatives of PennDER (or its predecessors), and independent engineering inspections every two years.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None
MAINTENANCE OPERATION RECORDS	None available

Name of Dam: ETHEL SPRINGS DAM

NDI # PA 01121

ITEM	REMARKS
SPILLWAY PLAN,	
SECTIONS, and DETAILS	No information available
OPERATING EQUIPMENT PLANS & DETAILS	No information available

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 0.34 sq.mi. (primarily low density residential)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1185.0 ft. M.S.L. (357.0 ac.-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1188.9 ft. M.S.L. (493.0 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1188.9 ft. M.S.L.

SPILLWAY: Principal

a. Crest Elevation 1185.0 ft. M.S.L.
b. Type 15 in. tile pipe inside 1 ft. by 4 ft. concrete inlet
c. Width of Crest Parallel to Flow 1 ft.
d. Length of Crest Perpendicular to Flow 4 ft.
e. Location Spillover At left abutment of dam
f. Number and Type of Gates None

OUTLET WORKS: A - Water Line, B - Blow-off Pipe

a. Type A - 10 in. C.I.P., B - 12 in. C.I.P. (blow-off)
b. Location Approximate location (on field sketch) A-Sta. 3+00, B-Sta. 2+50
c. Entrance Inverts Unknown
d. Exit Inverts A - Unknown, B - 1145.66 ft. M.S.L.
e. Emergency Drawdown Facilities 12 in. C.I.P. with valve draining into 18 in. tile pipe

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE No records available

APPENDIX C

PHOTOGRAPH LOCATION PLAN AND PHOTOGRAPHS

DETAILED PHOTOGRAPH DESCRIPTIONS

Overall View of Dam

Top Photo - (OV-T) Overall View of Upstream Face of Dam from Dike at Right Abutment

Bottom Photo - (OV-B) Overall View of Downstream Face of Dam from Left Abutment

Photograph Location Plan

Photo 1 - View Looking Downstream towards Dam along Crest of Dike

Photo 2 - View Looking Upstream along Crest of Dike

Photo 3 - View of Outlet for Canal

Photo 4 - View of Reservoir Outlet at Left Abutment

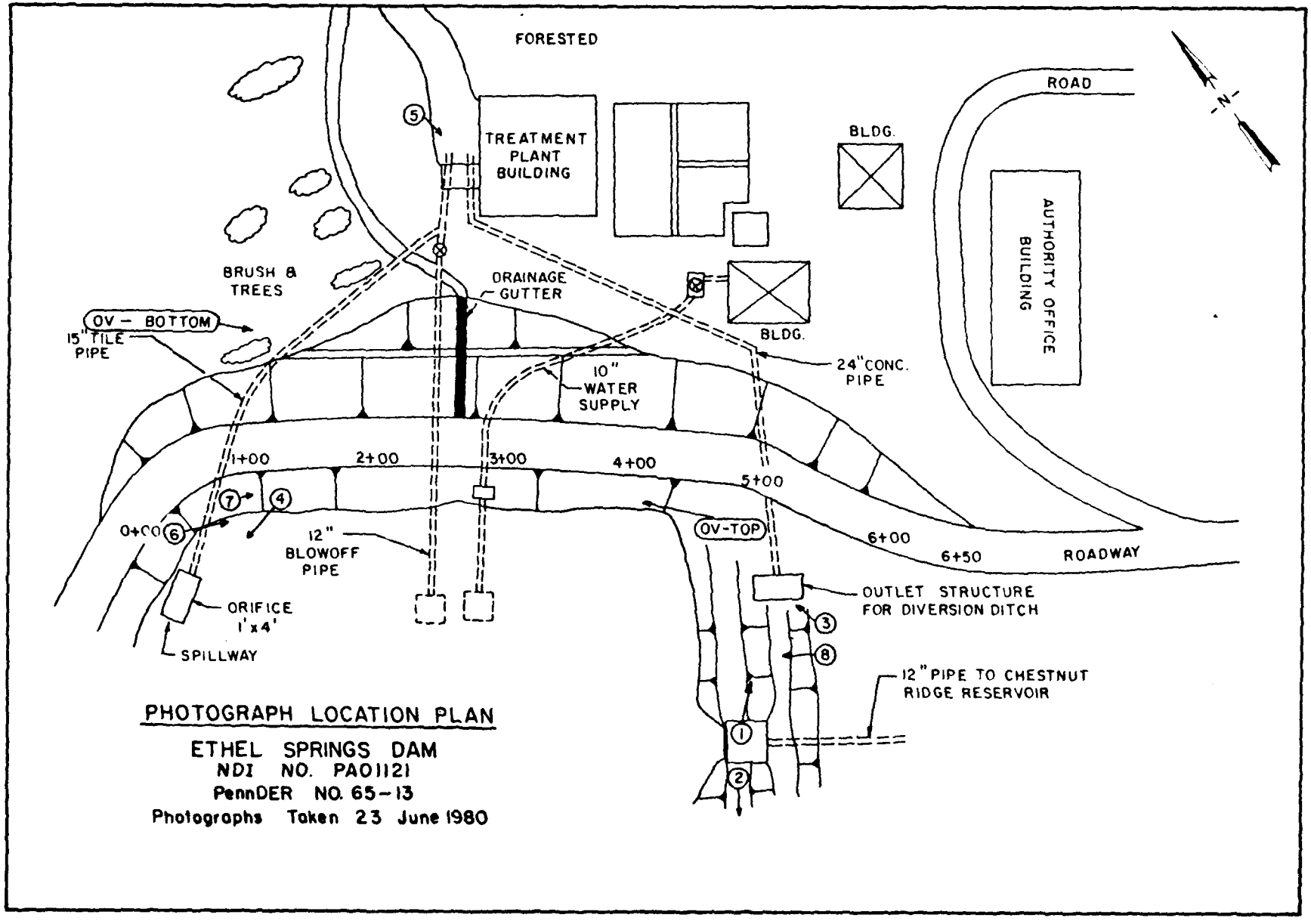
Photo 5 - View of Reservoir and Canal Outlets

Photo 6 - View of Upstream Face of Dam from Left Abutment (Note: tilting guardrail in center of photo is location of severe sloughing of upstream face of embankment)

Photo 7 - View of Erosion along Upstream Face of Embankment

Photo 8 - View of Seepage through Dike

Note: Photographs were taken on 23 June 1980.



PHOTOGRAPH LOCATION PLAN

ETHEL SPRINGS DAM
NDI NO. PA01121
PennDER NO. 65-13
Photographs Taken 23 June 1980

ETHEL SPRINGS DAM

PHOTO 1. View Looking Downstream towards Dam along Crest of Dike

PHOTO 2. View Looking Upstream along Crest of Dike

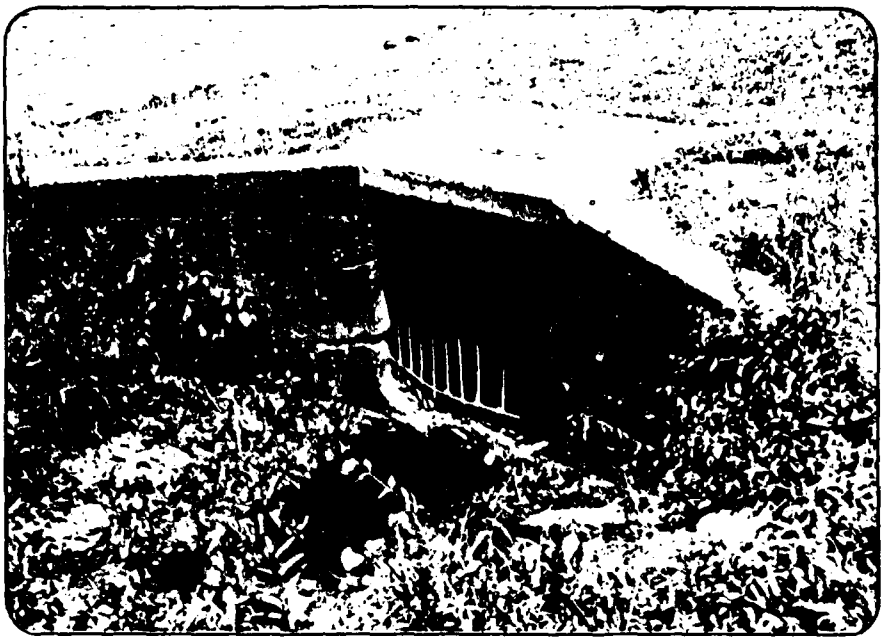


PHOTO 3. View of Outlet for Canal

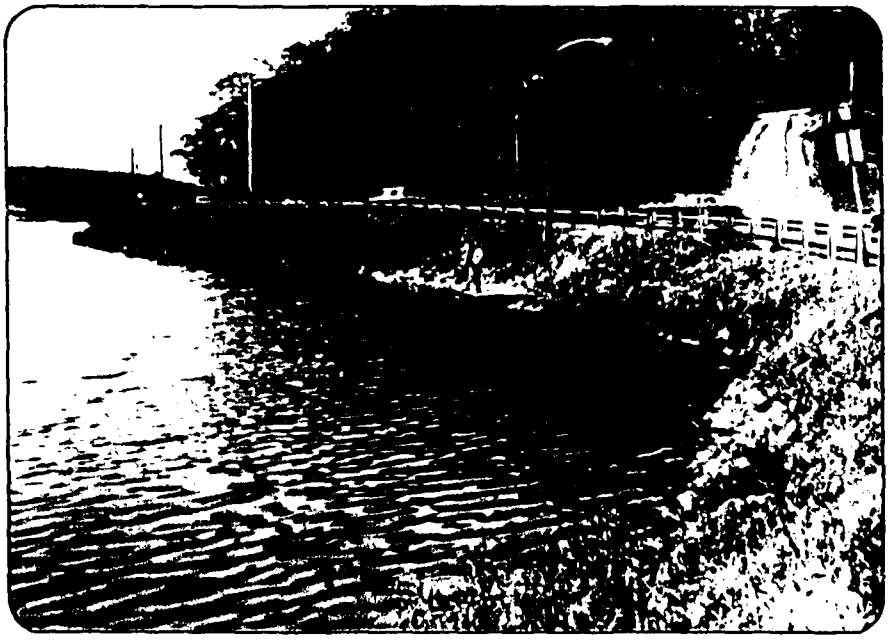


PHOTO 4. View of Reservoir Outlet at Left Abutment

PHOTO 5. View of Reservoir and Canal Outlets

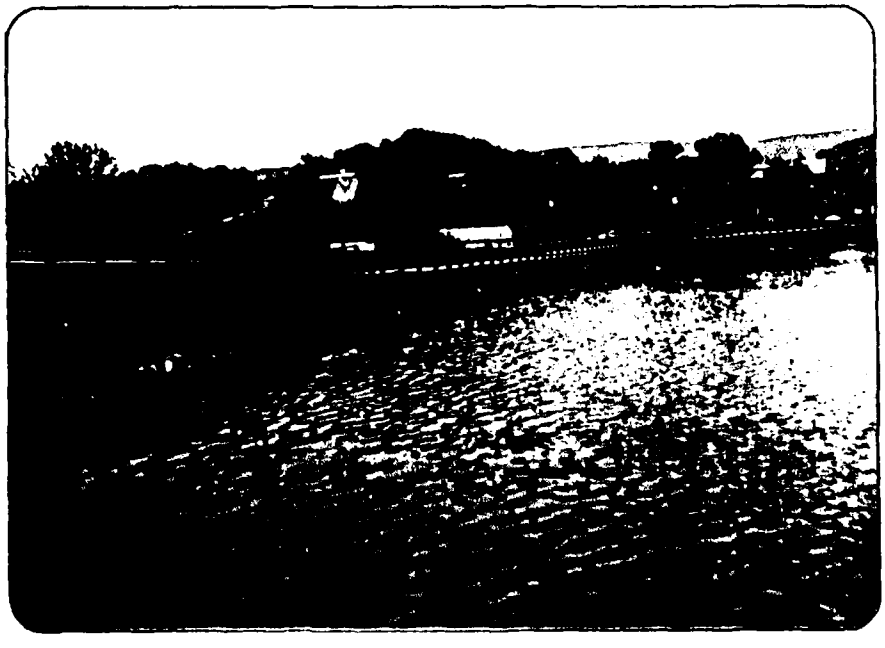


PHOTO 6. View of Upstream Face of Dam from Left Abutment

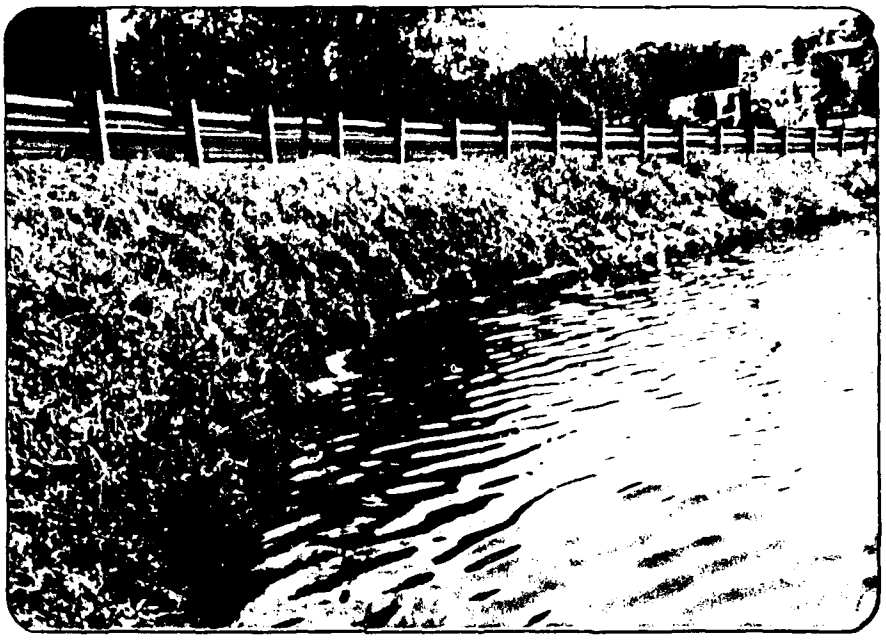


PHOTO 7. View of Erosion along Upstream Face of Embankment

PHOTO 8. View of Seepage through Dike

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject ETHEL SPRINGS DAM S.O. No. _____
APPENDIX D - HYDROLOGIC Sheet No. _____ of _____
AND HYDRAULIC ANALYSES Drawing No. _____
Computed by _____ Checked by _____ Date _____

TABLE OF CONTENTS

PREFACE

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic determinations presented in this Phase I Inspection Report are based on the use of a Snyder's unit hydrograph developed by the U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variations of watershed slopes, the Snyder's coefficients may yield results of limited accuracy for this watershed. As directed however, a further refinement of these coefficients is beyond the scope of this Phase I Investigation.

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: ETHEL SPRINGS DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.9 INCHES/24 HOURS[1]

STATION	1	2	3	4	5
Station Description	SUBBASIN NO. 1	SUBBASIN NO. 2			
Drainage Area (square miles)	0.26	0.08			
Cumulative Drainage Area (square miles)	0.34				
Adjustment of PMF for Drainage Area (%)[2]	Zone 7				
6 Hours	102				
12 Hours	120				
24 Hours	130				
48 Hours	140				
72 Hours	---				
Snyder Hydrograph Parameters					
Zone [3]	24				
C_p/C_t [4]	0.45/1.6				
L (miles) [5]	0.87	0.73			
L_{ca} (miles)[5]	0.37	0.31			
$t_p = C_t (L \cdot L_{ca})^{0.3}$ (hours)	1.14	1.02			
Spillway Data					
Crest Length (ft)	4				
Freeboard (ft)	3.9				
Discharge Coefficient	3.1				
Exponent	1.5				

[1] Hydrometeorological Report 33 (Figure 1), U.S. Army, Corps of Engineers, 1956.

[2] Hydrometeorological Report 33 (Figure 2), U.S. Army, Corps of Engineers, 1956.

[3] Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).

[4] Snyder's Coefficients.

[5] L = Length of longest water course from outlet to basin divide.
L_{ca} = Length of water course from outlet to point opposite the centroid of drainage area.

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject DESCRIPTION OF DRAINAGE BASIN ROUTING S.O. No.
Sheet No. 2 of 23
Drawing No.
Computed by WDL Checked by LAS Date 7-8-80

The watershed tributary to the dam is divided into two subbasins by the canal and dike which were constructed along the right side of the reservoir. The approximate boundaries of these subbasins are shown on the watershed map for this dam (sheet 6). It should be noted that flow in the canal cannot in any way bypass the dam; i.e. when the capacity of the canal and its outlet are exceeded, water will pond in the canal behind the dam and flow over the crest of the dike into the reservoir.

The typical crest of dike elevation is 1186.0 feet M.S.L.; the minimum crest elevation is 1185.9 feet M.S.L. This is only 1.0 feet above the crest of the reservoir outlet and 2.9 feet below the minimum top of dam elevation. Therefore, the dike will be overtopped (either from flow from the canal into the reservoir or from flow out of the reservoir into the canal) before the dam is overtopped. The generally poor condition of the dike indicates that it is likely to fail soon after overtopping. Failure of the dike means that the canal outlet will serve as an outlet for the reservoir.

To simulate the behavior of the dam, runoff hydrographs for each subbasin were computed and combined. The combined hydrograph was then routed through the reservoir using the combined discharge rating curves of the two outlets (the additional storage possible in the canal area was included in the reservoir storage capacity).

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject ETHEL SPRINGS LAKE S.O. No. _____
PENNDER No. 65-13 Sheet No. 3 of 23
HYDRAULIC DATA Drawing No. _____
Computed by WLS Checked by _____ Date _____

FOR SUBBASIN 1

DRAINAGE AREA ABOVE DAM: 1.84 SQ. IN. = 0.26 SQ. MI.
LONGEST HYDRAULIC PATH TO DAM: 4600 FT = 0.87 MI.
DISTANCE FROM CENTROID TO DAM: 1930 FT = 0.37 MI.
SNYDERS UNIT HYDROGRAPH COEFFICIENTS

$C_p = 0.45$
$C_T = 1.6$ (PLATE M)
$T_p = C_T (L \times L_{CA})^{0.3}$
$= 1.6 (0.87 \times 0.37)^{0.3} = 1.14$ HOURS

FOR SUBBASIN 2

DRAINAGE AREA ABOVE OUTLET: 0.55 SQ. IN. = 0.08 SQ. MI.
LONGEST HYDRAULIC PATH TO OUTLET: 3830 FT = 0.73 MI.
DISTANCE FROM CENTROID TO OUTLET: 1660 FT = 0.31 MI.
SNYDERS UNIT HYDROGRAPH COEFFICIENTS

$C_p = 0.45$
$C_T = 1.6$ (PLATE M)
$T_p = C_T (L \times L_{CA})^{0.3}$
$= 1.6 (0.73 \times 0.31)^{0.3} = 1.02$ HOURS

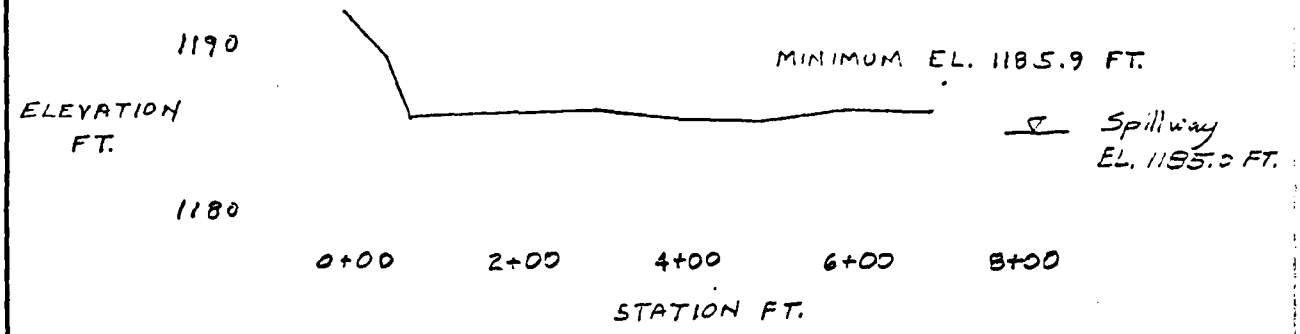
MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject ETHEL SPRINGS LAKE DAM S.O. No. _____
TOP OF DAM AND TOP OF Sheet No. 4 of 23
DIKE PROFILE Drawing No. _____
Computed by LED Checked by _____ Date 7/3/80

TOP OF DAM PROFILE

TOP OF DIKE PROFILE

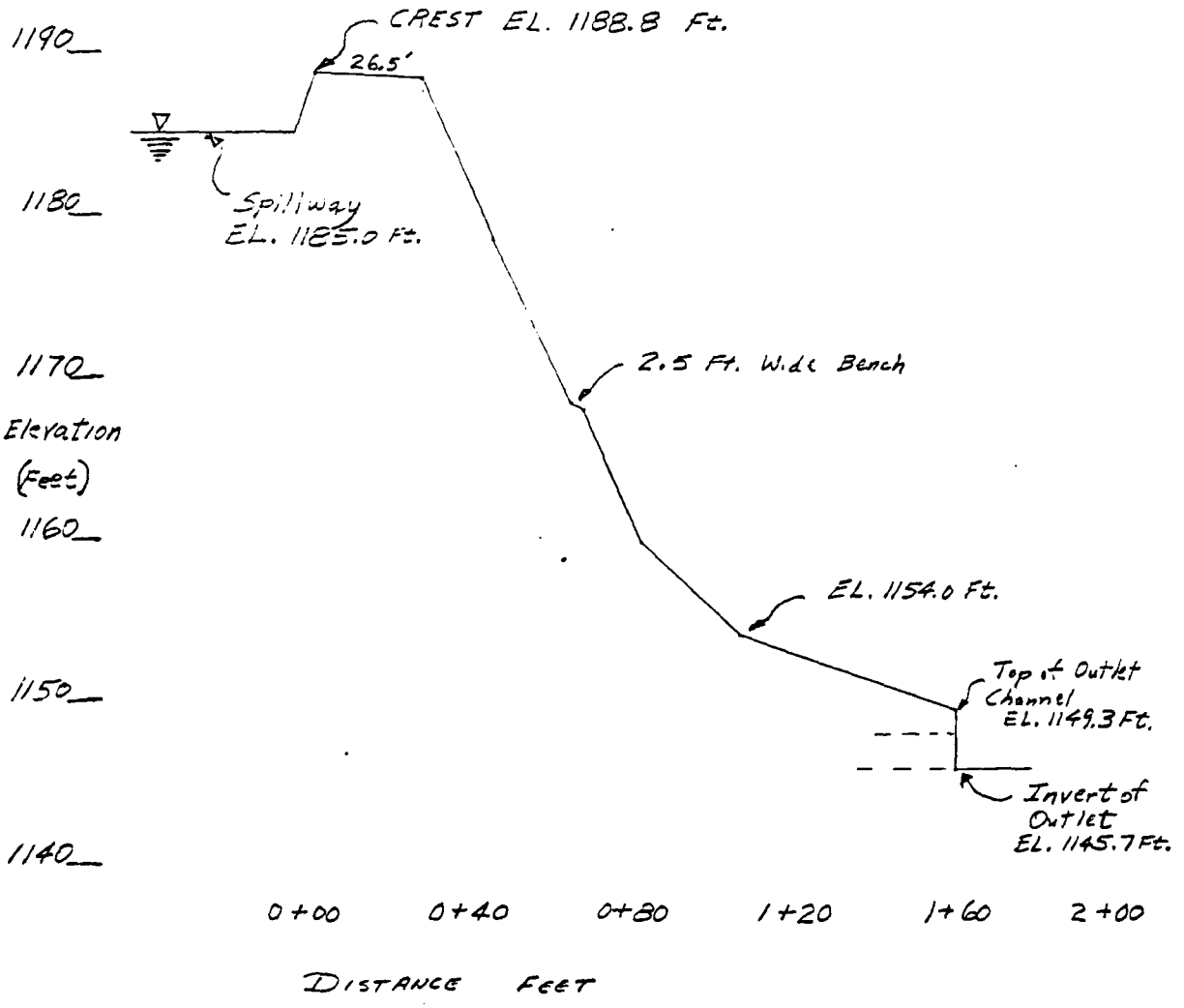


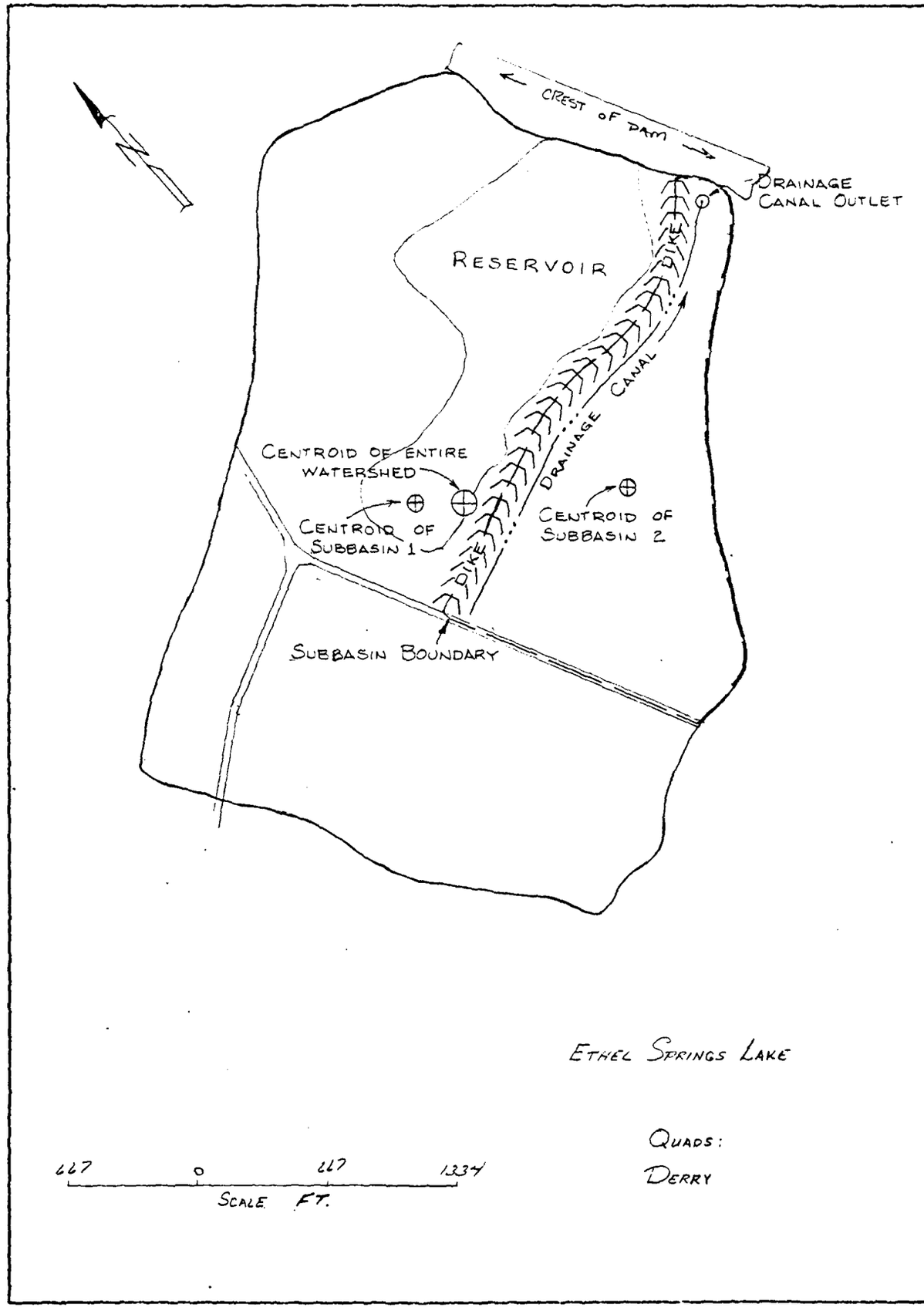
MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject ETHEL SPRINGS DAM S.O. No.
CROSS SECTION Sheet No. 5 of 23
Drawing No.
Computed by JGU Checked by Date 7/30/80

CROSS SECTION AT STATION 2+00




CREEST OF DAM
DRAINAGE CANAL OUTLET
RESERVOIR
DIKE
DRAINAGE CANAL
CENTROID OF ENTIRE WATERSHED
CENTROID OF SUBBASIN 1
CENTROID OF SUBBASIN 2
DIKE
SUBBASIN BOUNDARY
ETHEL SPRINGS LAKE
QUADS:
DERRY
667
0
667
1334
SCALE FT.

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject: ETHEL SPRINGS LAKE DAM
RIGHT SPILLWAY INLET
AND PIPE FLOW

S.O. No. ______
Sheet No. 7 of 23
Drawing No. ______

Computed by LAT   Checked by WDL   Date 7/21/80

ELEVATION	CONCRETE INLET		24" CONCRETE PIPE	
	ORIFICE FLOW	WEIR FLOW	PIPE FLOW	ORIFICE FLOW
1180.5	0	0	0	0
1181		4.4	42.2	23.9
1182		22.8	42.8	28.3
1183		49.0	43.4	32.1
1184		81.2	43.9	35.5
1185		118.4	44.5	38.6
1186	271.0	159.9	45.1	41.4
1187	294.6		45.6	44.1
1188	316.5		46.2	46.6
1189	336.9		46.7	49.0
1190	356.2		47.3	51.3

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Beaver, Pa. 15009

Subject ETHEL SPRINGS LAKE DAM S.O. No. ______
LEFT SPILLWAY INLET Sheet No. 8 of 23
AND SIDE FLOW Drawing No. ______
Computed by LAD Checked by WDL Date 7/21/80

ELEVATION	CONCRETE INLET		15" TILE PIPE	
	WEIR FLOW	ORIFICE FLOW	PIPE FLOW	ORIFICE FLOW
1185	0	0	0	0
.5	4.4		12.1	9.4
1186	12.4		12.2	10.3
1187	35.1	19.3	12.3	11.8
1188		27.3	12.5	13.2
1189		33.4	12.6	14.5
1190		38.5	12.8	15.7

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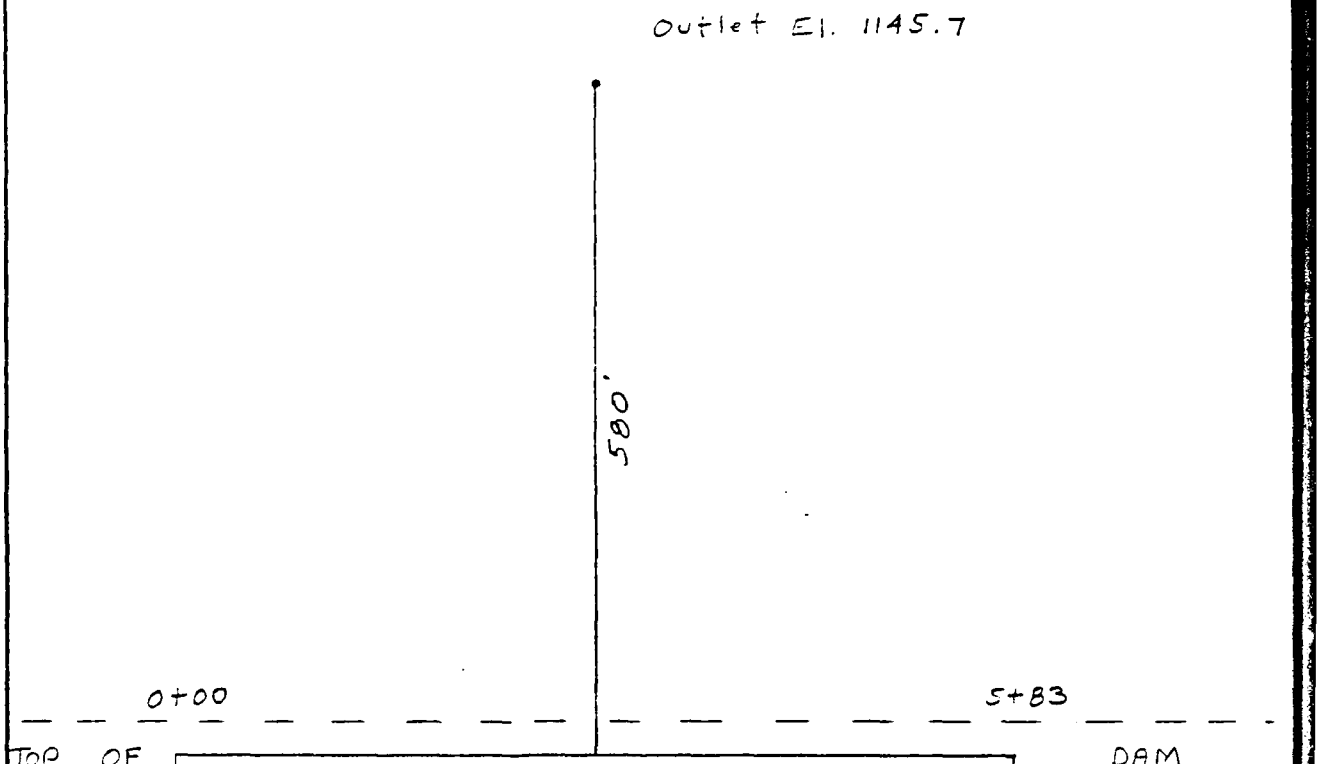
Subject ETTEL SPRINGS LAKE DAM S.O. No.
ESTIMATE PIPE LENGTHS Sheet No. 9 of 23
FOR SPILLWAYS Drawing No.
Computed by LAD Checked by WDL Date 7/19/60



Left Spillway
El. 1185.0
Total Pipe
Distance = 810' Ft.
Slope = $39.3'/810' = .0485'$
15" Tile Pipe

Right Spillway
El. 1180.5
Total Pipe
Distance = 1042' Ft.
Slope = $34.8'/1042' = .0334'$
24" Conc. Pipe

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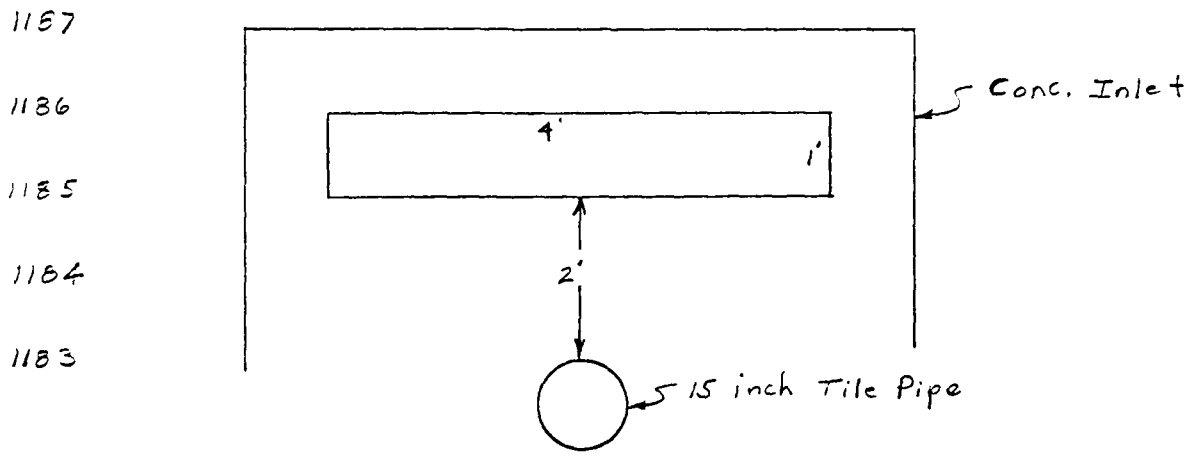
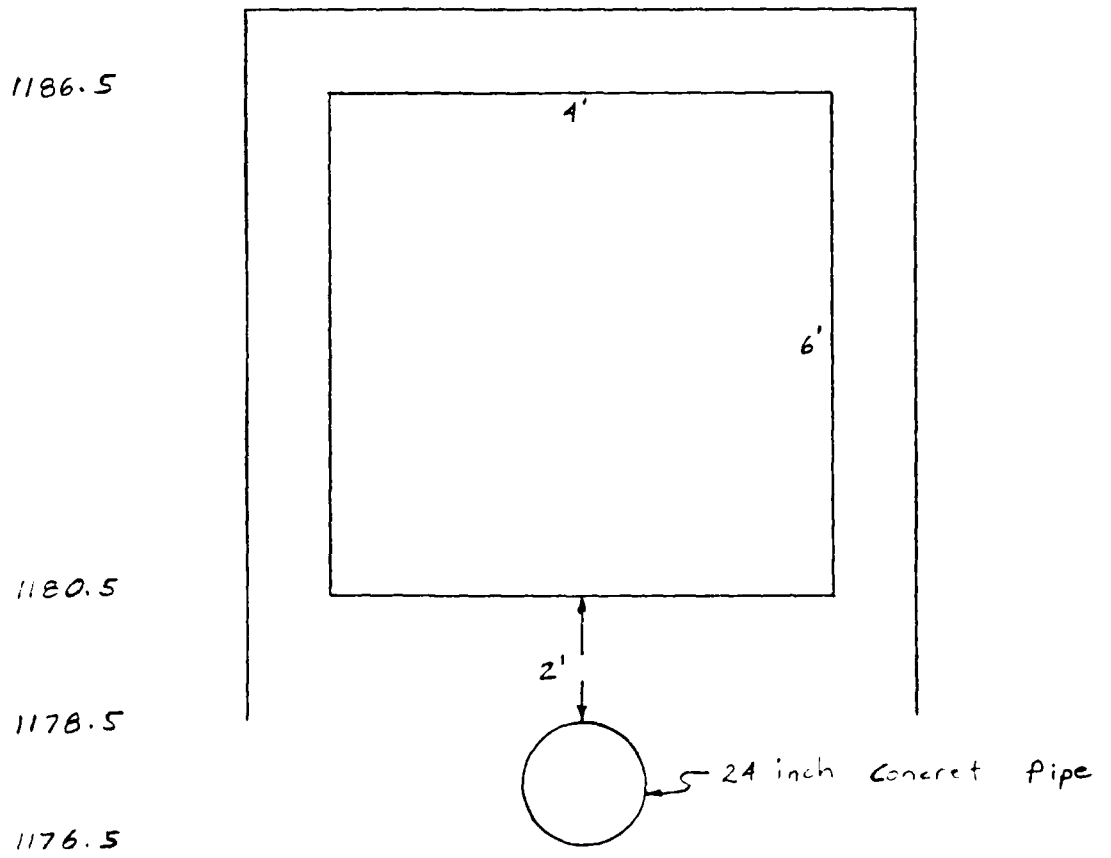
Subject ETHEL SPRINGS LAKE DAM S.O. No. _____
LEFT AND RIGHT SPILLWAY Sheet No. 10 of 23
INLETS Drawing No. _____
Computed by LAD Checked by WDL Date 7/12/90

LEFT SPILLWAY



RIGHT SPILLWAY



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Subject ETHEL SPRINGS LAKE DAM S.O. No.
LEFT SPILLWAY INLET Sheet No. 11 of 23
FLOW Drawing No.
Computed by LAD Checked by WLS Date 7/18/80

WEIR FLOW

$C = 3.1$

$L = 4$ Ft.

$H = .5$ FT TO 2.0 FT.

$Q = C L H^{3/2}$

$= (3.1)(4)(.5)^{3/2}$

$= 4.38$ ✓

$Q = (3.1)(4)(1.0)^{3/2}$

$= 12.4$ cfs ✓

$Q = (3.1)(4)(2.0)^{3/2}$

$= 35.07$ ✓

ORIFICE FLOW

$C = .6$ Pg 4-32 & 4-33 King & Brater, HANDBOOK OF HYDRAULICS

$A = 4' \times 1' = 4$ Sq. Ft.

$g = 32.2$ FT/sec.

$h = 1.0$ FT to 4.0 FT

$Q = C A \sqrt{2gh}$

$= (.6)(4)\sqrt{64.4 \times 1}$

$= 19.26$ cfs ✓

$Q = (.6)(4)\sqrt{64.4 \times 2}$

$= 27.24$ ✓

$Q = (.6)(4)\sqrt{64.4 \times 3}$

$= 33.36$ ✓

$Q = (.6)(4)\sqrt{64.4 \times 4}$

$= 38.52$ ✓

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Subject ETHEL SPRINGS LAKE DAM S.O. No. _____
16 INCH DIA. TILE PIPE Sheet No. 12 of 23
FLOW LEFT SPILLWAY Drawing No. _____
Computed by LAT Checked by WWS Date 7/21/80

ORIFICE FLOW

$Q = C A \sqrt{2g h}$

$= 5.92 \sqrt{2.5}$

$= 9.36$ ✓

$Q = 5.92 \sqrt{3}$

$= 10.25$ ✓

$Q = 5.92 \sqrt{4}$

$= 11.84$ ✓

$Q = 5.92 \sqrt{5}$

$= 13.24$ ✓

$Q = 5.92 \sqrt{6}$

$= 14.51$ ✓

$Q = 5.92 \sqrt{7}$

$= 15.67$ ✓

$C = .6$ (King & Brater Pg 4-32)

$A = \pi r^2 \quad (3.14)(.63)^2$

$= 1.23$ Sq. Ft. ✓

$g = 32.2$ FT/sec

$h = 3.0$ FT TO 7.0 FT

$Q = 5.92 \sqrt{H}$ ✓

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Subject ETLE. SCS [illegible] S.O. No. _____
15 inch D.a. Tile Pipe Sheet No. 13 of 23
Flow, Left Spillway Drawing No. _____
Computed by LED Checked by WLS Date 7/19/80

$Q = \frac{0.463}{n} d^{8/3} S^{1/2}$ Fg 6-15 (SCS)

$d = 15 in = 1.25 Ft.$

$S = .0485$

$n = .014$ Fg 6-16

$= \frac{0.463}{.014} (1.25)^{8/3} (.0485)^{1/2}$

$= 13.21$ cfs Full Flow at Elev. 1183 (Mannings Equa.)

PIPE FLOW

$Q = \frac{A(2g H)^{1/2}}{(1 + K_e + K_b + K_c[L])^{1/2}}$

$Q = \frac{1.23(64.4 H)^{1/2}}{(1 + .78 + .4 + .03[810])^{1/2}}$

$Q = 1.9182 (H)^{1/2}$

$= 1.9182 (39.8)^{1/2}$

$= 12.10$

$Q = 1.9182 (40.3)^{1/2}$

$= 12.18$

$Q = 1.9182 (41.3)^{1/2}$

$= 12.33$

$Q = 1.9182 (42.3)^{1/2}$

$= 12.48$

$Q = 1.9182 (43.3)^{1/2}$

$= 12.62$

$Q = 1.9182 (44.3)^{1/2}$

$= 12.77$

15 INCH TILE PIPE

$A = \pi r^2$
$= (3.14)(.63)^2$
$= 1.23$ Sq. FT.

$g = 32.2$ FT/sec

$H = 39.8$ FT. TO 44.3 FT.

$n = .014$

$L = 810$ FT.

$K_e (K_o) = .78$
SCS Pg 5.5-6

$K_b (K_s) = .4$
SCS Pg 5.5-10

$K_c (K_p) = .0270$
SCS Pg 5.5-4

EL. 1185.0 - 1145.7 = 39.3 H of Head to Inlet
Determine Pipe Flow from El. 1185.5 to 1190

THE NATIONAL ENGINEERING HANDBOOK, SECTION 5, HYDRAULICS, SOIL CONSERVATION SERVICE (SCS), IS THE PUBLICATION REFERENCED IN THE ABOVE CALCULATIONS.

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Subject ETHEL SPRINGS LANE PCM S.O. No. _____
24 INCH R.C. CONCRETE Sheet No. 14 of 23
SIDE FLOW, EIGHT COMLWAY Drawing No. _____
Computed by LAD Checked by WLS Date 7/21/80

ORIFICE FLOW

$Q = CA\sqrt{2gh}$

$= (.6)(3.14)\sqrt{64.4 \times h}$

$= 15.12\sqrt{h}$

$Q = 15.12\sqrt{2.5}$
$= 23.91$

$Q = 15.12\sqrt{3.5}$
$= 28.29$

$Q = 15.12\sqrt{4.5}$
$= 32.07$

$Q = 15.12\sqrt{5.5}$
$= 35.46$

$Q = 15.12\sqrt{6.5}$
$= 38.55$

$Q = 15.12\sqrt{7.5}$
$= 41.41$

$Q = 15.12\sqrt{8.5}$
$= 44.08$

$Q = 15.12\sqrt{9.5}$
$= 46.60$

$Q = 15.12\sqrt{10.5}$
$= 48.99$

$Q = 15.12\sqrt{11.5}$
$= 51.27$

$C = .6$ King & Brater Pg 4-32

$A = \pi r^2 = (3.14)(1)^2$
$= 3.14$ Sq. Ft.

$g = 32.2$ Ft/sec

$h = 2.5$ to 11.5

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Subject ETHEL SPRINGS LOWE DAM S.O. No.
EIGHT SPILLWAY INLET Sheet No. 15 of 23
FLOW Drawing No.
Computed by LAD Checked by WLS Date 7/21/80

ORIFICE FLOW

$Q = CA\sqrt{2gh}$

$= (.6)(24.0)\sqrt{64.4 \times h}$

$= 115.56\sqrt{h}$

$C = .6$ King & Brater Pg 4-32

$A = 4' \times 6'$
$= 24.0$ Sq. Ft.

$g = 32.2$ Ft/Sec

$h = 5.5$ Ft to 9.5 Ft.

$Q = 115.56\sqrt{5.5}$
$= 271.01$

$Q = 115.56\sqrt{6.5}$
$= 294.62$

$Q = 115.56\sqrt{7.5}$
$= 316.47$

$Q = 115.56\sqrt{8.5}$
$= 336.91$

$Q = 115.56\sqrt{9.5}$
$= 356.18$

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Subject ETHEL SPRINGS LAKE DAM S.O. No.
SPILLWAY WEIR Sheet No. 16 of 23
FLOW OVER INLET Drawing No.
Computed by LED Checked by WLS Date 7/18/90

$Q = CLH^{3/2}$

$= (12.4)(0.5)^{3/2}$

$= 4.38$

$Q = (12.4)(1.0)^{3/2}$

$= 12.40$

$Q = (12.4)(1.5)^{3/2}$

$= 22.78$

$Q = (12.4)(2.0)^{3/2}$

$= 35.07$

$Q = (12.4)(2.5)^{3/2}$

$= 49.02$

$Q = (12.4)(3.0)^{3/2}$

$= 64.43$

$Q = (12.4)(3.5)^{3/2}$

$= 81.19$

$Q = (12.4)(4.0)^{3/2}$

$= 99.20$

$Q = (12.4)(4.5)^{3/2}$

$= 118.37$

$Q = (12.4)(5.0)^{3/2}$

$= 138.64$

$Q = (12.4)(5.5)^{3/2}$

$= 159.94$

$Q = (12.4)(6.0)^{3/2}$

$= 182.24$

$C = 3.1$

$L = 4$ FT

$H = 0.5$ FT TO 6.0 FT.

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Subject ETHEL SPRINGS LAKE DAM S.O. No.
24 inch Dia. Concrete Sheet No. 17 of 23
Pipe Flow, Right Spillway Drawing No.
Computed by LAD Checked by WCS Date 7/18/80

$$Q = \frac{0.463}{n} d^{8/3} S^{1/2}$$ SCS Pg 6-15

$d = 24\text{ in} = 2.0\text{ Ft.}$

$S = .0334$

$n = .013$

$$= \frac{0.463}{.013} (2.0)^{8/3} (.0334)^{1/2}$$

$= 41.33$ c.f.s Full Flow at Elev. 1182.5 (Mannings Equa.)

PIPE FLOW

$$Q = \frac{A(2gH)^{1/2}}{(1 + K_e + K_b + K_c[L])^{1/2}}$$

$$Q = \frac{(3.14)(64.4 \times H)^{1/2}}{(1 + .78 + .4 + .01[1042])^{1/2}}$$

$Q = 7.0988(H)^{1/2}$

$Q = 7.0988 (35.3)^{1/2}$
$= 42.18$

$Q = 7.0988 (36.3)^{1/2}$
$= 42.77$

$Q = 7.0988 (37.3)^{1/2}$
$= 43.36$

$Q = 7.0988 (38.3)^{1/2}$
$= 43.93$

$Q = 7.0988 (39.3)^{1/2}$
$= 44.50$

$Q = 7.0988 (40.3)^{1/2}$
$= 45.07$

$Q = 7.0988 (41.3)^{1/2}$
$= 45.62$

$Q = 7.0988 (42.3)^{1/2}$
$= 46.17$

$Q = 7.0988 (43.3)^{1/2}$
$= 46.71$

$Q = 7.0988 (44.3)^{1/2}$
$= 47.25$

24 INCH CONC. PIPE

$A = \pi r^2$
$= (3.14)(1)^2$
$= 3.14$ Sq. FT.

$g = 32.2$ FT/sec.

$n = .013$

$L = 1042$ FT.

$K_e (K_o) = .78$
SCS Pg 5.5-6

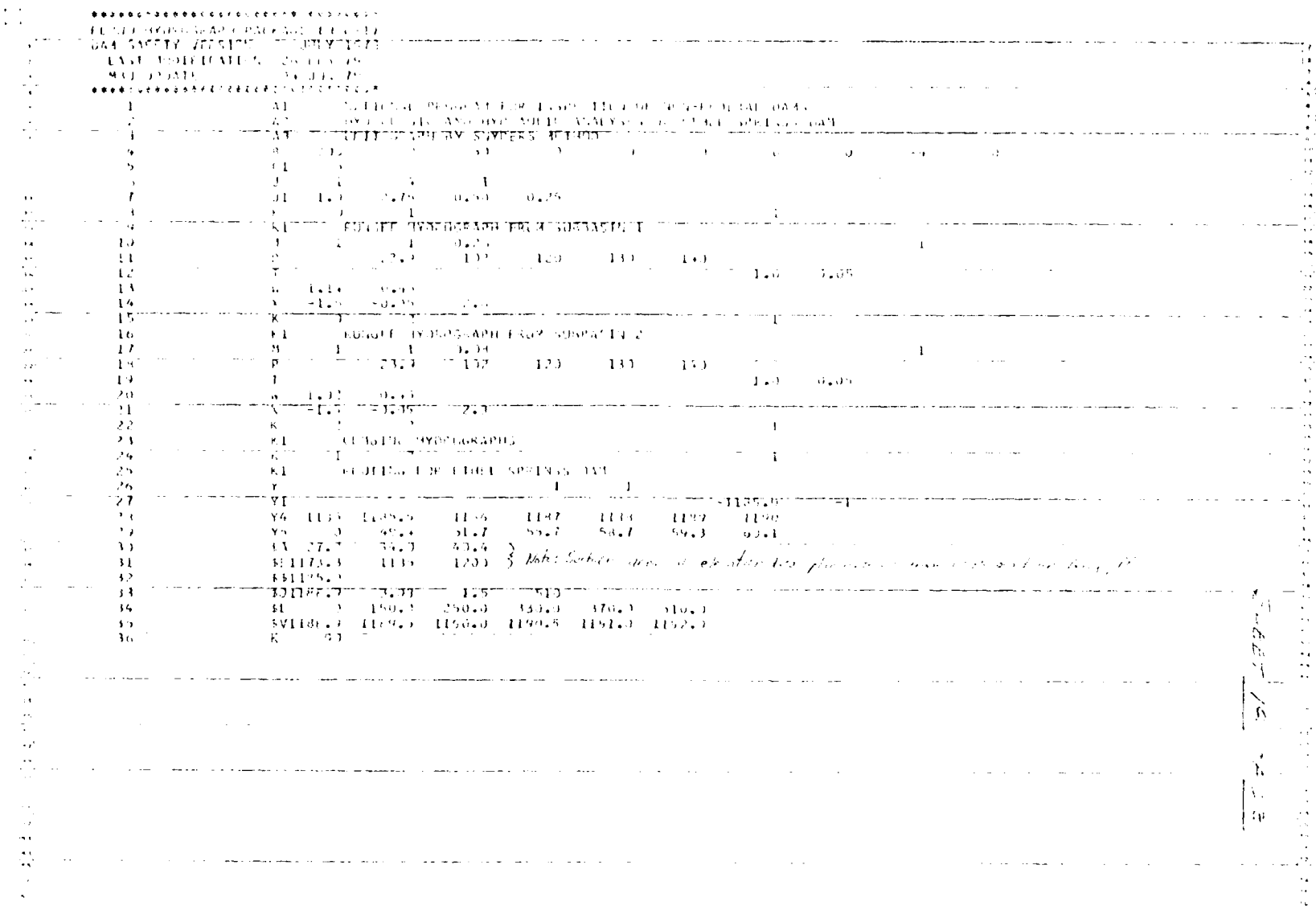
$K_b (K_s) = .4$
SCS Pg 5.5-10

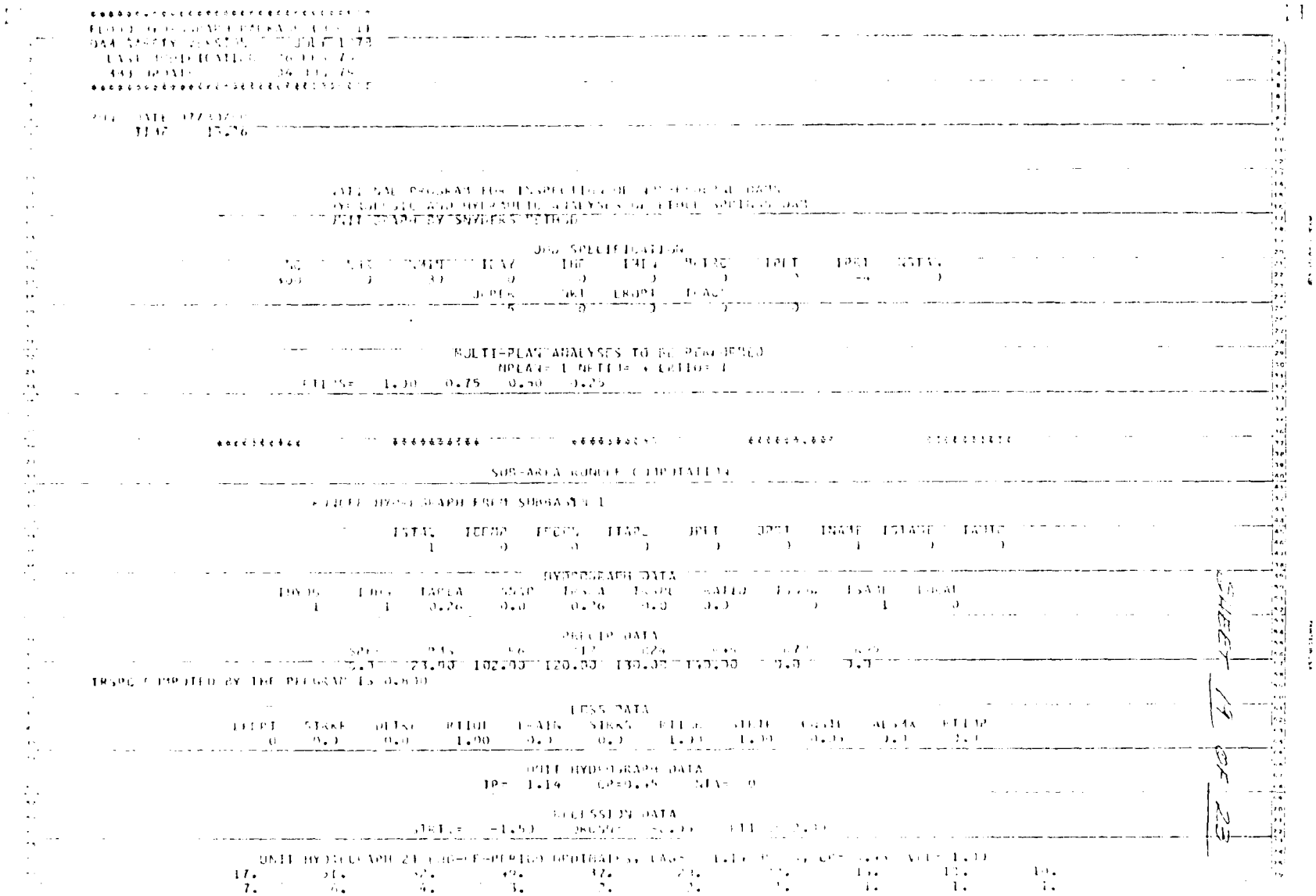
$K_c (K_p) = .0124$
SCS Pg 5.5-4

$H = 35.3$ FT. to 44.3 FT.

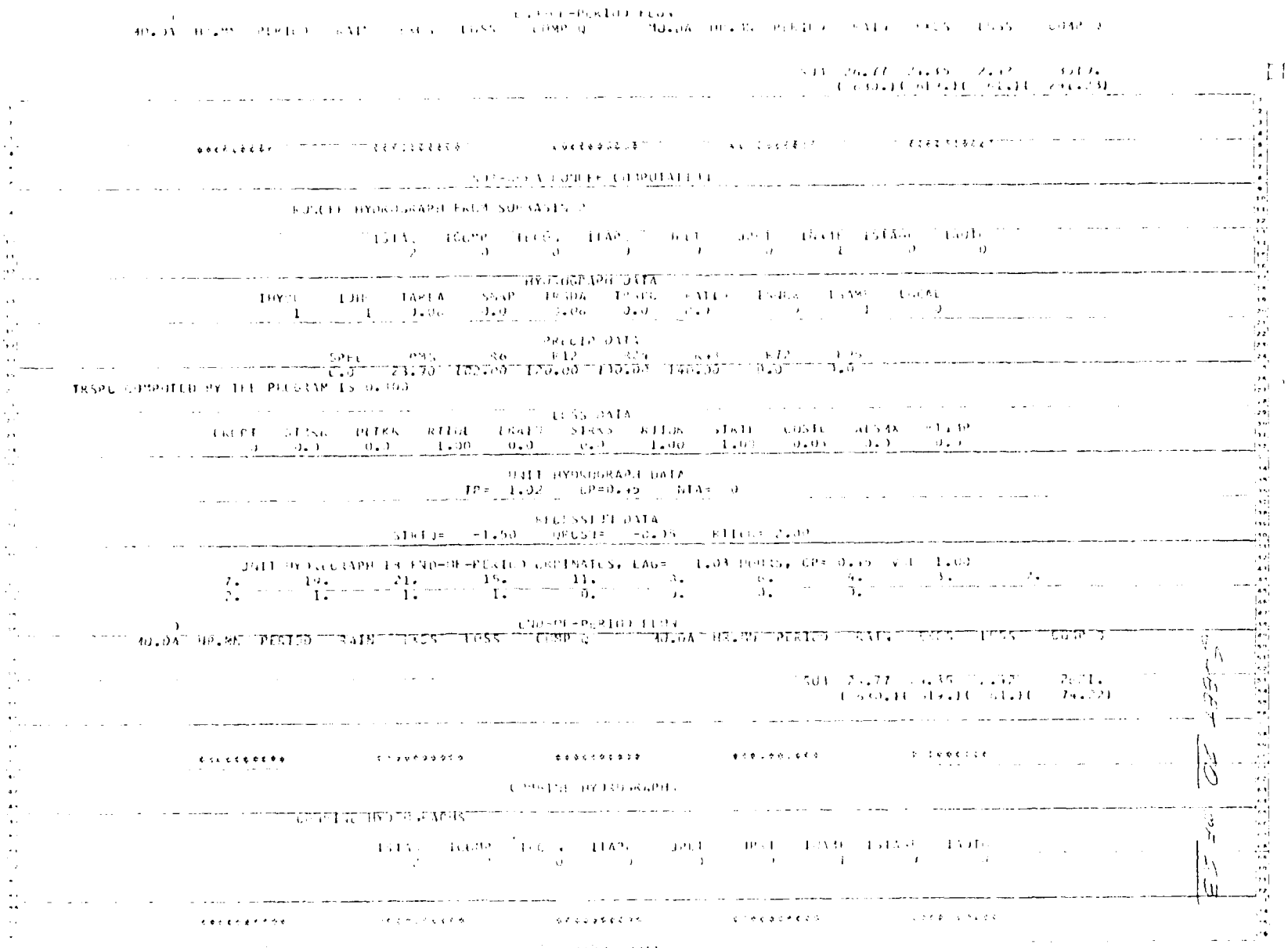
El. 1180.5 - 1145.7 = 34.8 Ft. of Head to Inlet
Determine Pipe Flow from El. 1181 To 1190

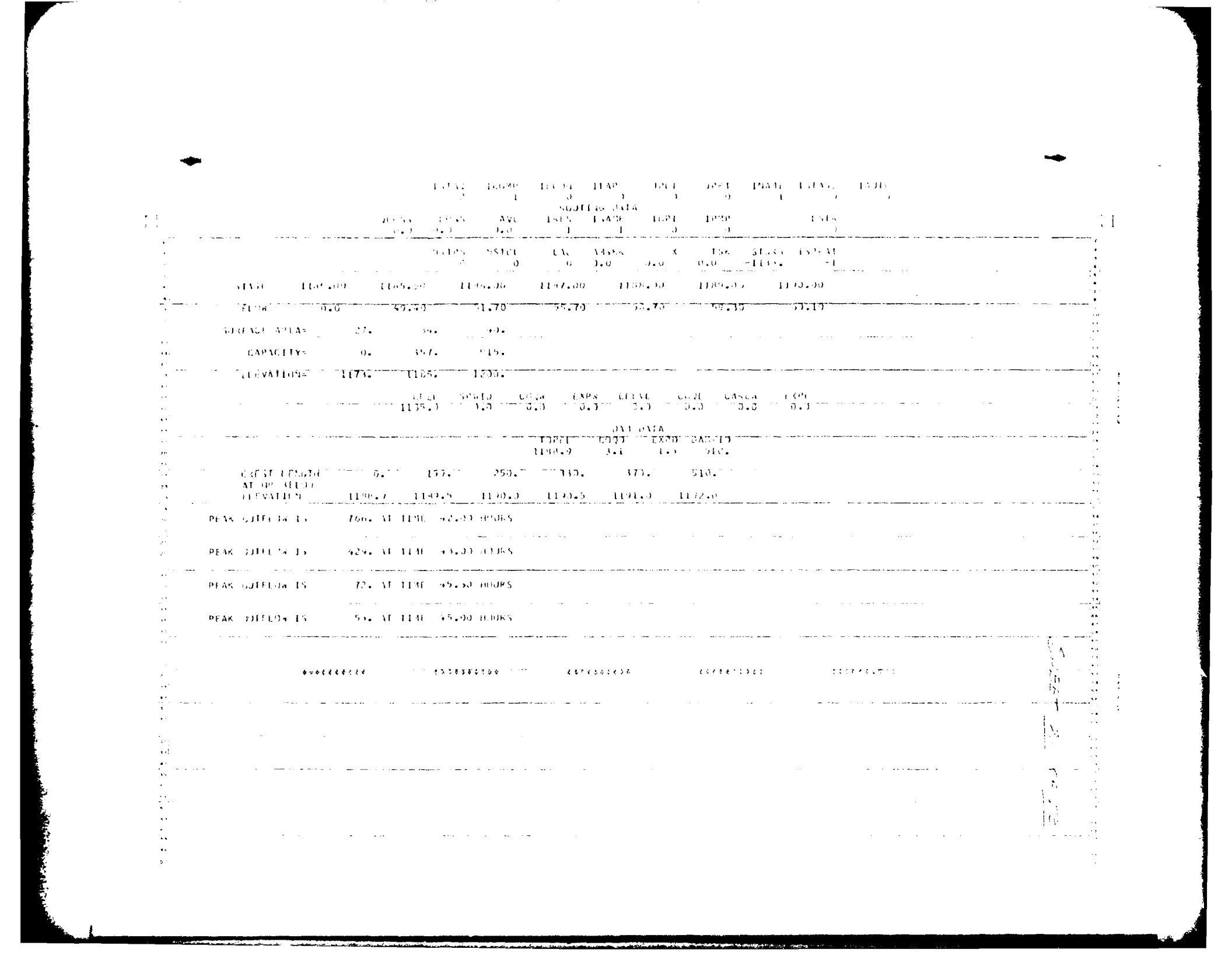
The National Engineering Handbook, Section 5, Hydraulics, Soil Conservation Service (SCS), is the publication referenced in the above calculations.





SHEET 17 OF 23





PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 1.00	RATIO 2 0.75	RATIO 3 0.50	RATIO 4 0.25
				RATIOS APPLIED TO FLOWS			
HYDROGRAPH AT	1	0.65	1	691.	519.	345.	173.
	(	5.77)	(	19.57)(	14.66)(	9.78)(	4.89)(
HYDROGRAPH AT	2	0.85	1	225.	169.	112.	56.
	(	2.21)	(	6.37)(	4.78)(	3.15)(	1.59)(
2 COMBINED	2	1.50	1	915.	687.	458.	229.
	(	3.88)	(	25.92)(	19.46)(	12.97)(	6.48)(
ROUTED TO	2	1.50	1	766.	429.	77.	55.
	(	3.88)	(	21.69)(	12.15)(	2.19)(	1.55)(

SHEET 22 OF 23

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	[illegible]	[illegible]	[illegible]
	STORAGE	357.	357.	[illegible]
	OUTFLOW	0.	0.	[illegible]

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.7[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.25	[illegible]	[illegible]	417.	[illegible]	[illegible]	[illegible]	[illegible]

SHEET 22 OF 23

APPENDIX E

PLATES

CONTENTS

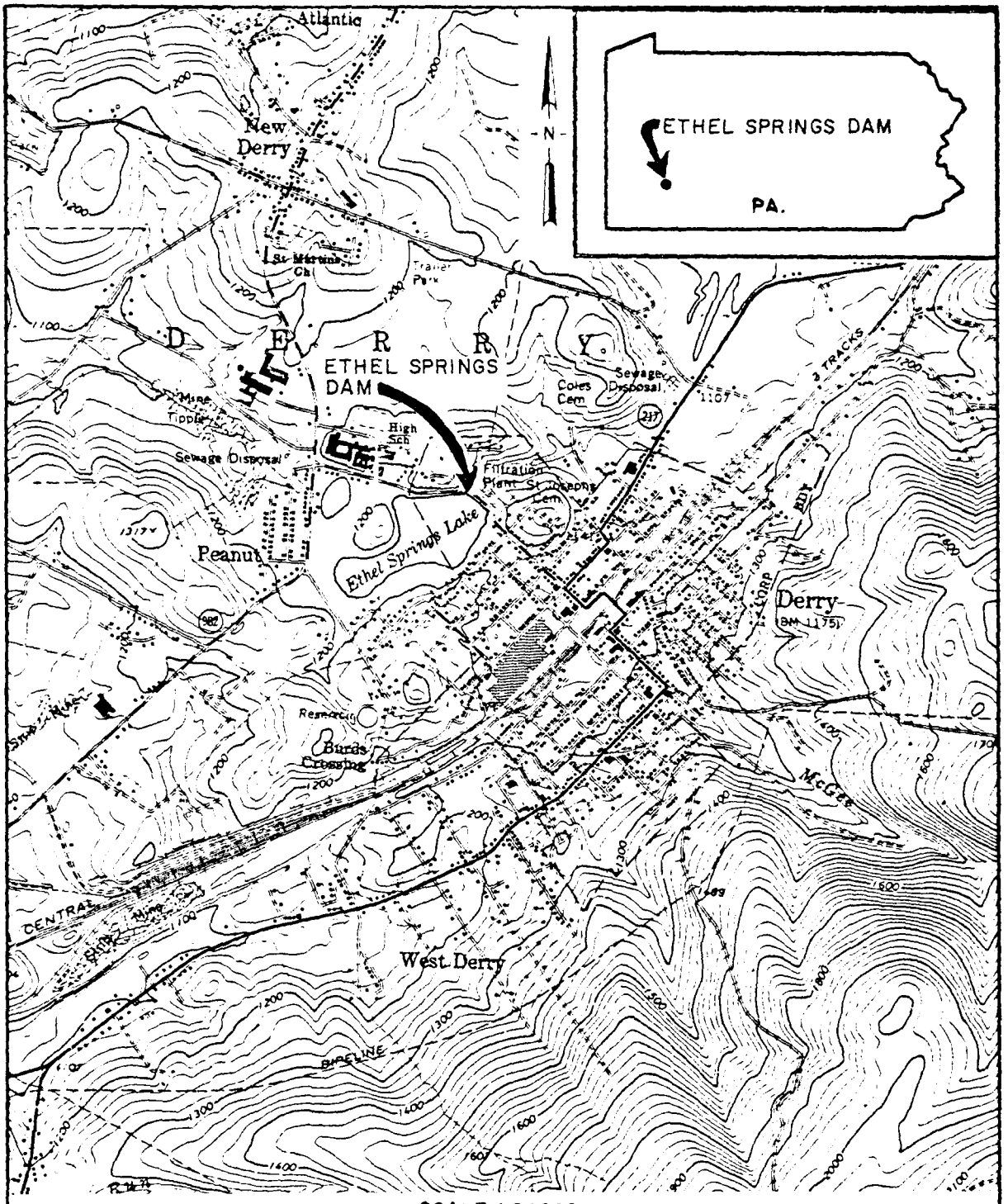
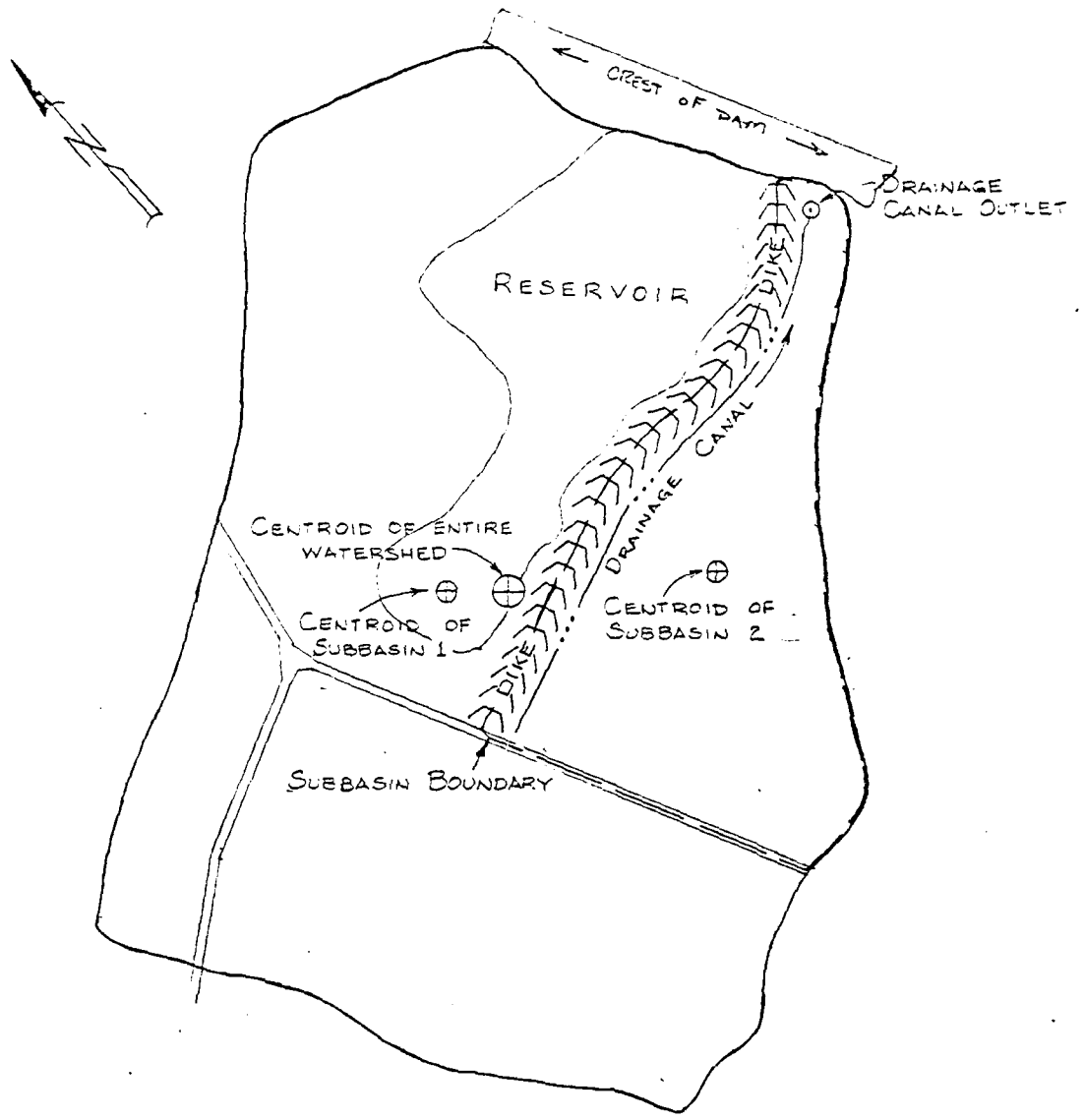


PLATE 1 LOCATION PLAN

ETHEL SPRINGS DAM

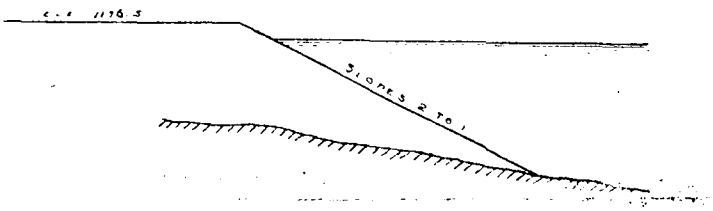


ETHEL SPRINGS DAM
PLATE 2 WATERSHED MAP

667 0 667 1334
SCALE FT.

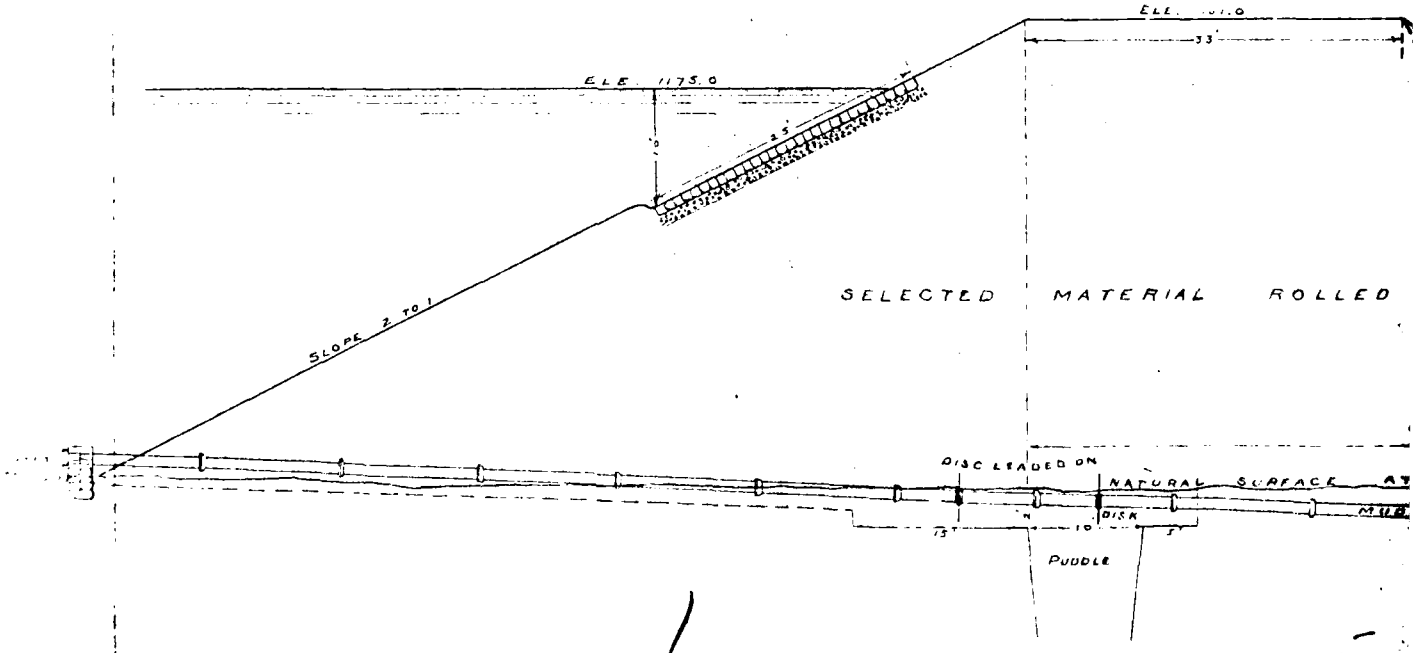
DERRY PA. WATER WORKS
DETAILS IMPOUNDING RESERVOIR
—1900—

SIDE EMBANKMENTS



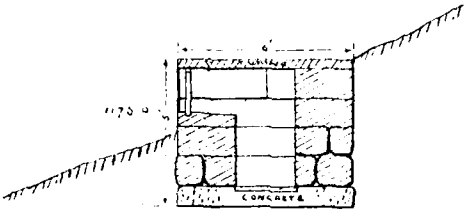
SCALE 10 TO 1

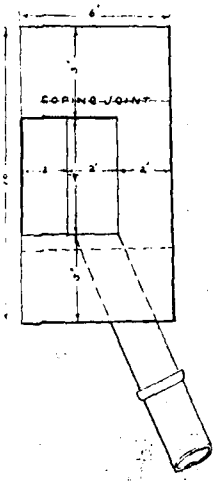
MAIN EMBANKMENT SECTI



KS

RVOIR

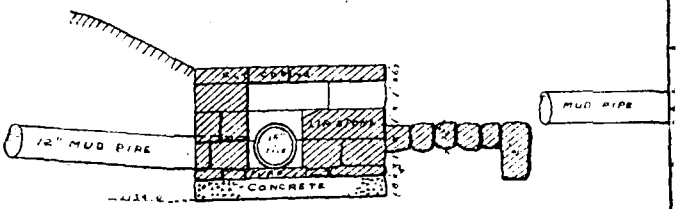




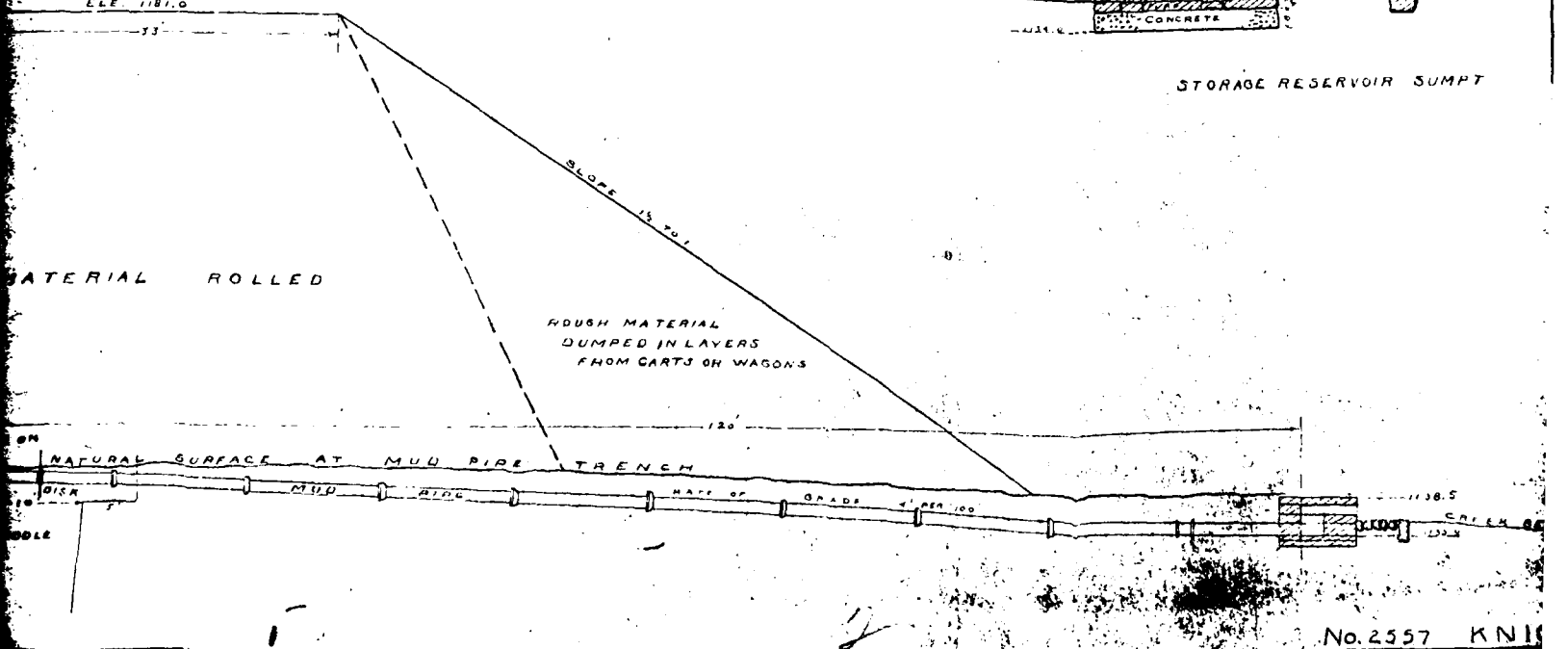
SPILL WAY

SCALE ¼" TO 1'

EMBANKMENT SECTION

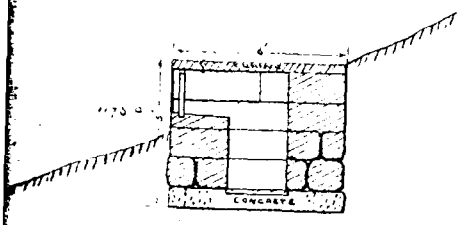


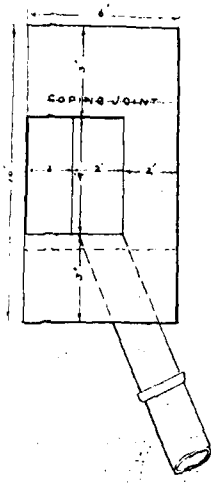
STORAGE RESERVOIR SUMPT



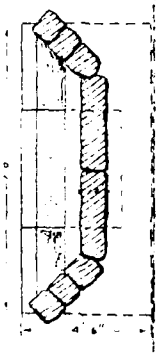
ATERIAL ROLLED

No. 2557 KNI

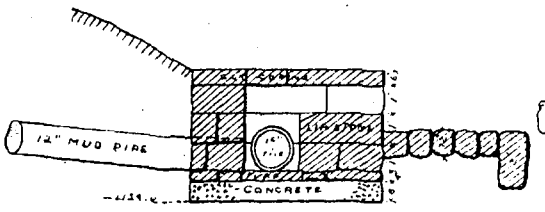


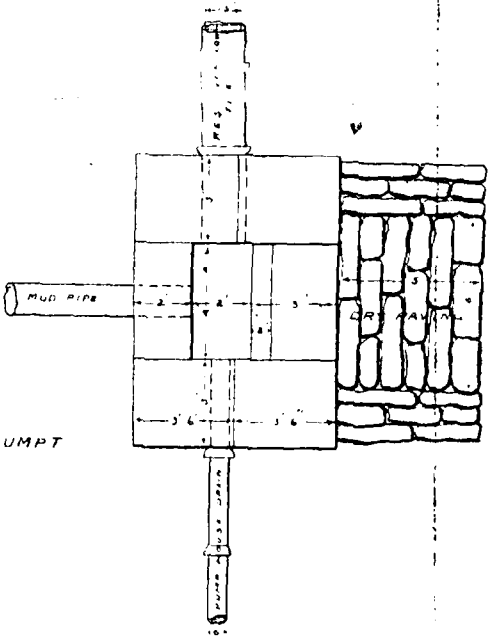


SPILL WAY



SCALE ¼" TO 1'





STORAGE RESERVOIR SUMP

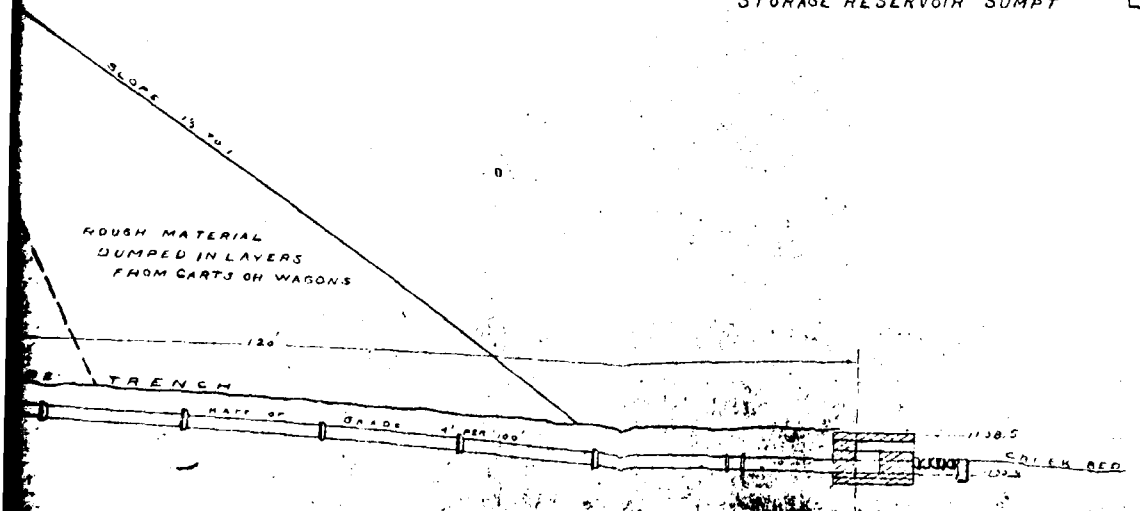


PLATE 3

No. 2357 KNIGHT & HOPKINS

3

APPENDIX F

REGIONAL GEOLOGY

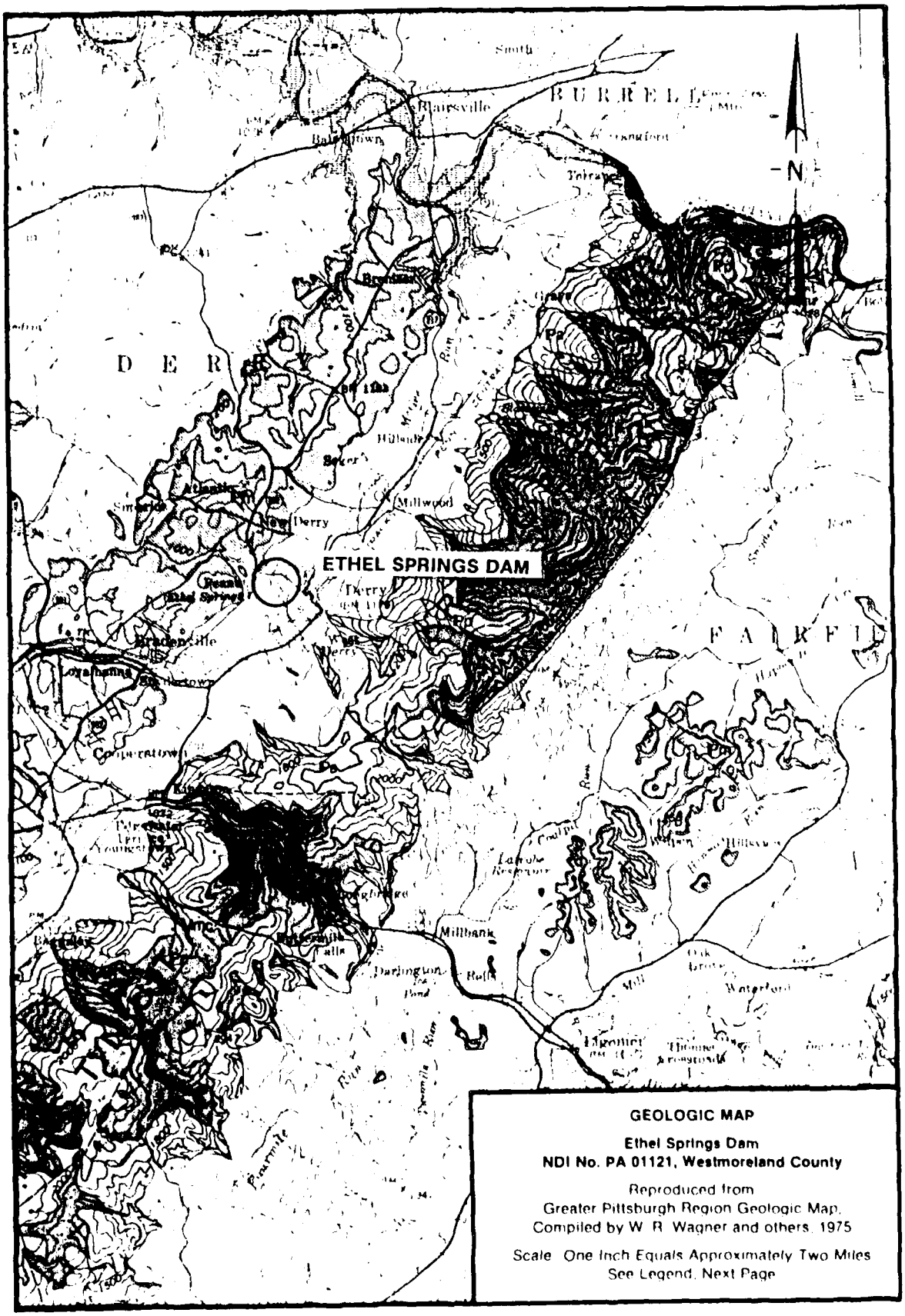
ETHEL SPRINGS DAM
NDI No. PA 01121, PennDER No. 65-13

REGIONAL GEOLOGY

Ethel Springs Dam is located in an unglaciated section of the Appalachian Plateaus physiographic province. Bedrock units below the dam are members of the Conemaugh Group, Pennsylvanian System. These members consist of cylic sequences of sandstone, shale, red beds, thin limestone and coal. The Ames limestone is the contact bed between the Casselman and Glenshaw formations (subdivisions of the Conemaugh Group). In this area the Ames limestone has not been sufficiently mapped to provide a breakdown between the two formations.

Several coal seams are possibly located beneath the dam, including the Upper Freeport, Lower Freeport, Upper Kittanning, Middle Kittanning, Lower Kittanning, Clarion, Brookville, and Mercer coals. The thicknesses of the coals beneath the dam are not known and according to "Bituminous Coal Resources in Western Pennsylvania"[1] (Sholes, M.A. and V.W. Skema, 1974) no mining activity has occurred in the immediate vicinity of the dam.

[1]Pennsylvania Bureau of Topographic and Geologic Survey, Mineral Resource Report 68.



GEOLOGIC MAP

Ethel Springs Dam
NDI No. PA 01121, Westmoreland County

Reproduced from
Greater Pittsburgh Region Geologic Map,
Compiled by W. R. Wagner and others, 1975

Scale: One Inch Equals Approximately Two Miles
See Legend, Next Page

GEOLOGY MAP LEGEND

GROUP	FORMATION		DESCRIPTION
	Alluvium	Qal	Sand, gravel, clay
	Terrace deposits		Sand, clay, gravel on terraces above present rivers, includes Carmichaels Formation.
DUNKARD	Greene		Cyclic sequences of sandstone, shale, red beds, thin limestones and coals.
	Washington	Pw	Cyclic sequences of sandstone, shale, limestone, and coal, contains Washington coal bed at base.
	Waynesburg	PPw	Cyclic sequences of sandstone, shale, limestone and coal; contains Waynesburg coal bed at base.
MONONGAHELA		Pm	Cyclic sequences of shale, limestone, sandstone and coal; contains Pittsburgh coal bed at base.
CONEMAUGH	Casselman	Pcc	Cyclic sequence of sandstone, shale, red beds and thin limestone and coal.
	Ames		
	Glenshaw	Pcg	Cyclic sequences of sandstone, shale, red beds and thin limestone and coal; several fossiliferous limestone, Ames limestone bed at top.
ALLEGHENY	Vanport	Pa Pa	Cyclic sequences of shale, sandstone, limestone, and coal; contains Brookville coal at base and Upper Freeport coal at top; within group are the commercial Vanport limestone and Kittanning and Clarion coals.
POTTSVILLE		Pp	Sandstone and shale; contains some conglomerate and locally minable coal.
Mauch Chunk		Mmc	Red and green shale with some sandstone; contains Wymps Gap and Loyalhanna limestones.
Pocono		Mp	Sandstone and shale with Burgoon sandstone at top.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